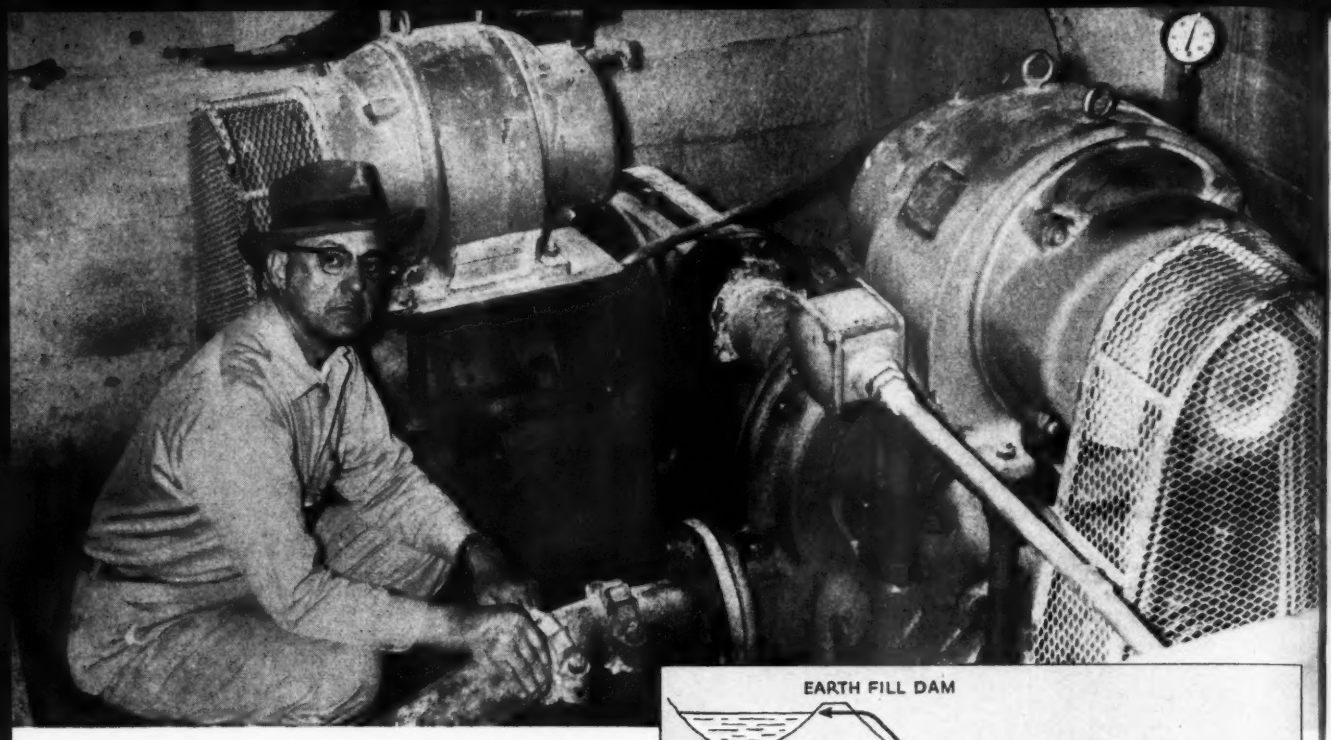
MINING CONGRESS JOURNAL

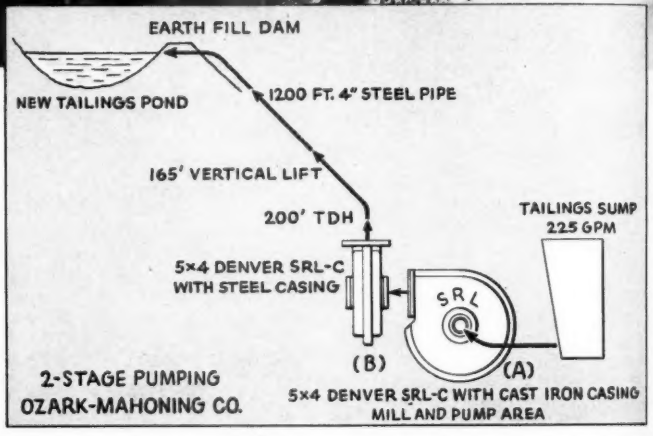
AMERICAN MINING CONGRESS

AMC

OCTOBER 1958

IN THIS ISSUE . . .





Tailings given 1200 ft. Up-Hill Lift with

DENVER SRL·C PUMPS

Only available site for new tailings pond for the Jamestown, Colorado, fluorspar mill of the Ozark-Mahoning Co., was located 1200' upstream. Vertical lift to new pond was 165'. Pulp consists of 7% solids at 60% — 325 mesh, 100% — 100 mesh. Disposal rate, 225 gpm.

Pump A draws from tailings sump at mill and, to gain lift and capacity, discharges directly into intake of Pump B. Tailings leave Pump B at a total dynamic head of 200' and proceed through 1200' of 4" steel pipe to new pond site.

Dependability and low maintenance are features the personnel at Ozark-Mahoning appreciate most with these DENVER SRL Pumps.

If you have an abrasive or corrosive pumping problem, no matter how simple or unusual, we invite you to let DECO engineers prepare a detailed recommendation on the correct size and type of pump to fit your requirements.

Sizes to 3000 gpm.

"The firm that makes its friends happier, healthier and wealthier"

DECO ENGINEERED — DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

DENVER EQUIPMENT COMPANY

1400 Seventeenth St. • Denver 17, Colorado

• DENVER
• NEW YORK
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• VANCOUVER
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Complete Mill Equipment

MINING CONGRESS JOURNAL

VOL. 44 OCTOBER 1958 NO. 10

Indexed regularly by Engineering Index, Inc.

CONTENTS

Opinions expressed by authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

ARTICLES

DEPARTMENTS

ON OUR COVER

Timbermen raise a post at an Arizona mine. Significant changes in the techniques of mine support have taken place over the last decade. Read how a large Montana operator holds the ground in "Mine Support at Butte," page 44.

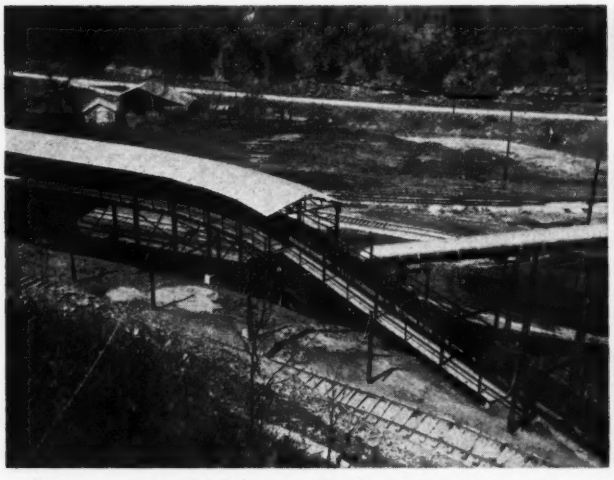
Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $5.00. Single copies, $0.30. February Annual Review Issue, $1.25. Entered as Second-class Matter, January 30, 1915, at the Post Office at Washington, D. C.

NOW - with S-D Automatic Overlapping End Cars...

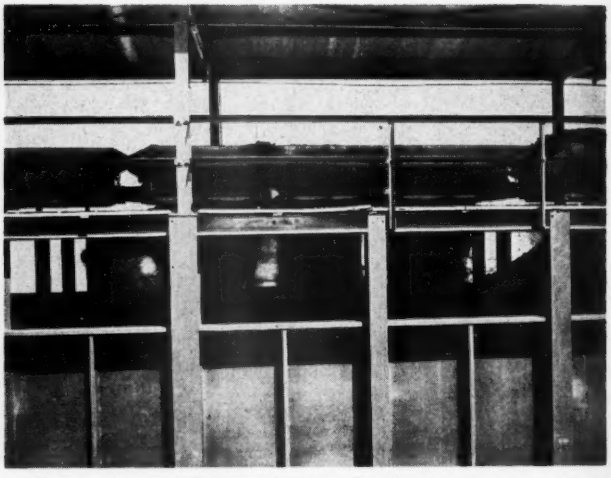
Here is Automatic Loading and Dumping

SOUTH-EAST COAL COMPANY'S Camp Branch, Ky., mine is an impressive example of alert, hustling management and operating personnel. Only a few machines and men are required for this simple, organized operation. Above you see the tipple and coal storage bin. Conveyor runs continuously hauling coal from bin to tipple. Bin provides surge capacity to permit successive dumping of long trips. Only 2 men are needed at these facilities.

SLATE BIN is located a few hundred feet from Coal Storage Bin. The small bin in picture above provides track ballast. The same S-D Automatics that haul coal also haul out the top and bottom rock to Slate Bin. S-D "Automatic" Overlapping End Cars more than meet South-East's planned program for haulage at absolute minimum cost! Not only can a single trip of S-D Overlapping End Cars be loaded continuously and dumped one-after-another without stopping, but they provide maximum haulage safety! Automatic couplers eliminated accidents. Fingers, hands, arms, no longer have reason to be between cars, nor can a man get between cars after coupling!



Here you see trip of S-D Automatic Overlapping End Cars as it enters bin. Conveyor under track hauls coal from bin to tipple.

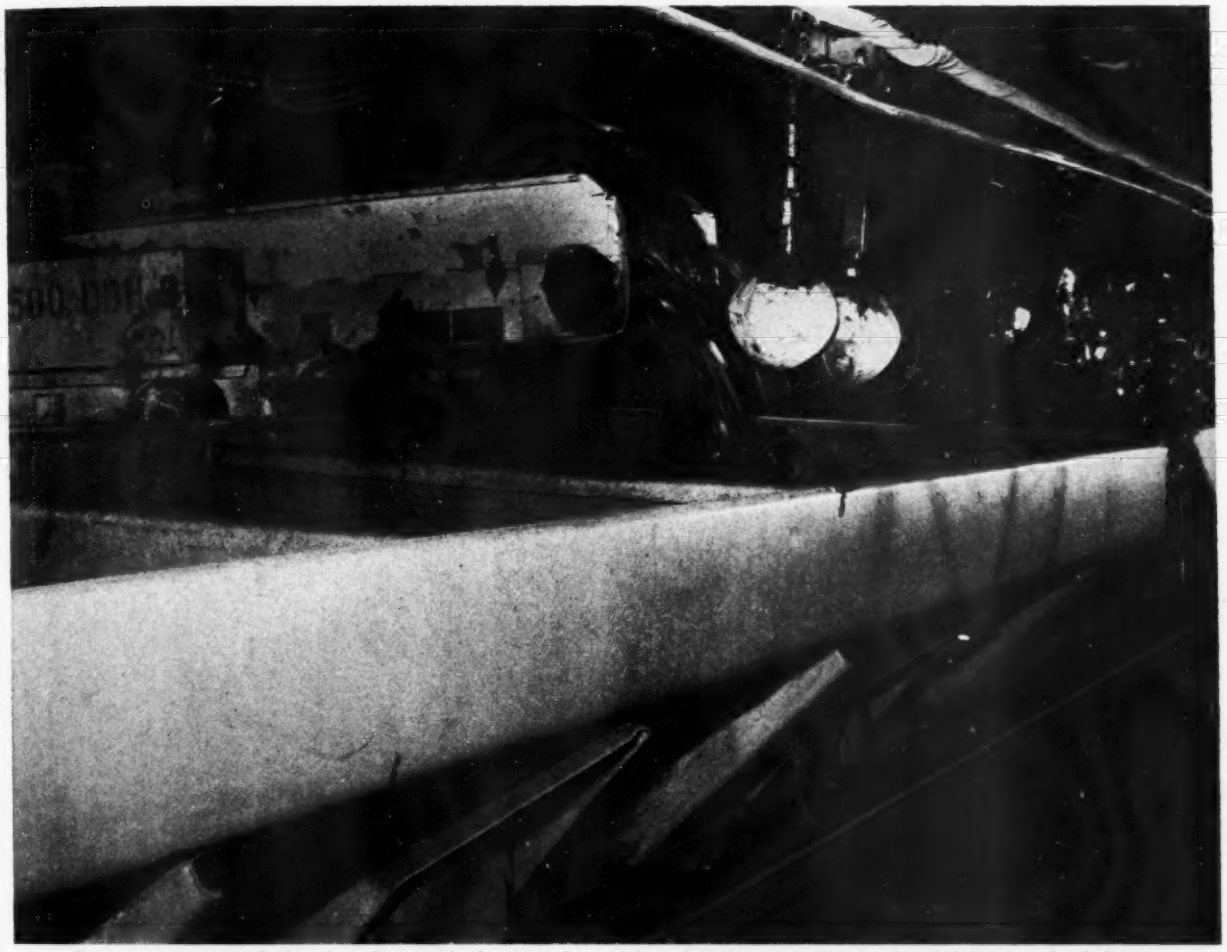


Close-up above of S-D Automatic Bottom Dumping Cars was made while trip was dumping. You can see bottom dumping doors actually down and the coal discharging.

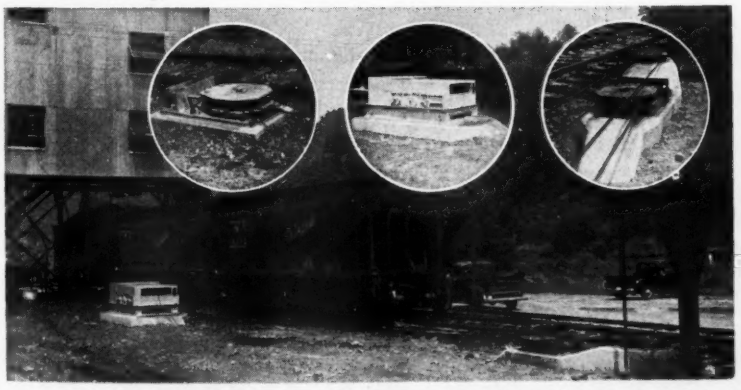
TWENTY-NINE MEN, including Mr. Chester Cureton, day-shift foreman, pictured above, and Mr. T. B. Smith, night-shift foreman, operate one continuous miner two shifts at this mine. At present, operations consist of driving and grading a main line heading a distance of some 27,000 feet. In early 1960, additional sections will bring this mine to its designed capacity of 5,000 tons per day with no change in the basic haulage system.

This S-D Automatic Haulage System operates with minimum manpower requirements. The motor crew not only handles all haulage, but checks the performance of the manless automatic loading station. Clinton Fleming, above, is day-shift motorman. Earl Adams is motorman on night shift. These men are in charge of the system and make it tick like clockwork, leaving a trip of 10 to 16 empties to be loaded and hauling out a pre-loaded trip of 10 to 15 cars.

...and Maximum Haulage Safety!



Here you see untouched action photograph showing why and how S-D Automatic Overlapping End Cars are loaded continuously one-after-another at South-East. Note coal coming off conveyor. See how portion of coal is finishing-up loading forward car while the other portion is starting to load empty car. (Trip was caught in movement while overlapping ends were directly under conveyor). Switches operated by ball movement activate hydraulic spotter which moves trip.



S-D "BROWNIE" Double-Rope Hoist moves railroad cars under loading chute at tipple.

SANFORD-DAY

KNOXVILLE, TENNESSEE

- S-D Mine Cars, all types and kinds.
- Precision S-D Mine Wheels.
- Tough, year-after-year wheel service by special S-D wheel Hard-Facing Process (this can really save you money and eliminate downtime).
- S-D "Brownie" Hoists.
- S-D Car Spotters, all types, including special drop bottom car spotters.
- S-D Mine Sheaves and Rollers.
- S-D Automatic Loading Stations for Mine Car and Railroad Car Loading points.
- S-D Slusher-Trains for mining and construction industries.
- S-D Gismo and Transloaders for mining and construction industries.

This is an Actual Operation Picture-Report on the performance of S-D Automatic Overlapping End Cars. Savings provided by these cars are tremendous! One large mine recently converted its big Rotary Dump operation into a similar open track bin to realize the automatic-loading and automatic-dumping savings obtained only by S-D Automatic Overlapping End Cars. Every S-D Automatic Overlapping End Car installation is earning major savings! We have movies showing these cars, large and small, in regular mine haulage. May we show them to you? Write us today.

SANFORD-DAY IRON WORKS, INC., KNOXVILLE, TENN.

Typical of 71-B applications is this job in a western copper mine. Machine is loading out overburden. Note widespread crawlers which keep the big 71-B steady and stable throughout dig-and-swing cycle.

When you need power YOU GET IT with the 3-yd. Bucyrus-Erie 71-B shovel

The torque converter drive on Bucyrus-Eries gives you cushioned power — automatically balanced speed and torque to meet every load demand.

Engine and main machinery are cushioned against shock loads. The torque converter automatically delivers the right amount of power to meet the minimum and maximum demands of the machinery.

Air controls let you put that power to work smoothly, efficiently. Graduated valves are used on main operating clutches, delivering power *as you need it* — not in a sudden blast.

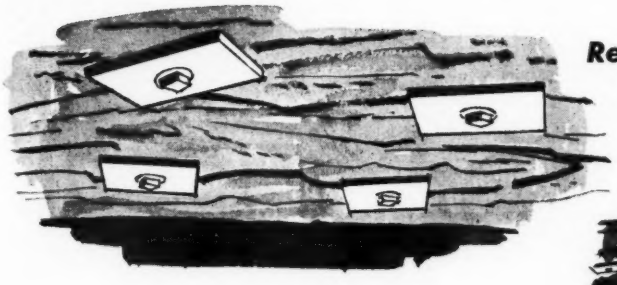
Where you want action quick you get it. On dipper trip, steering clutches and brakes, and swing brake, poppet type valves are used — full on or off.

Bucyrus-Erie engineers are specialists in delivering power through machines *job-tested* on every type of job — big and small. Write today and get all the facts about the machine you need. Bucyrus-Erie Company, South Milwaukee, Wisconsin. 548E58

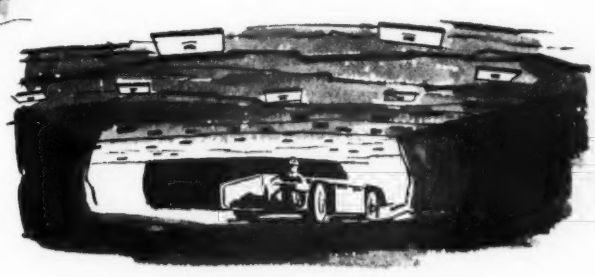
BUCYRUS ERIE

MODERNIZE to economize!

Here's why it pays to bolt your roof

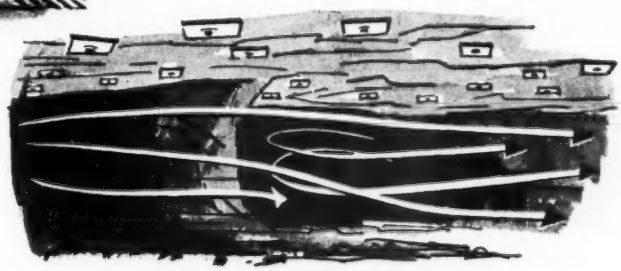


Reduces rock falls . . . improves safety

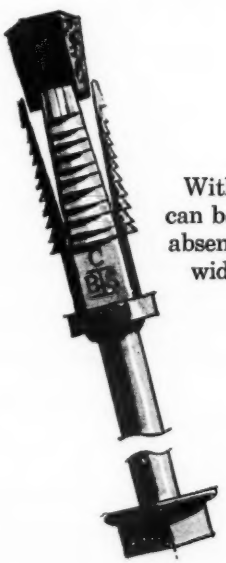


Permits wide haulageways . . . increases clearance

Makes mechanized equipment easier to maneuver



Improves ventilation . . . no bulky supports to store



With roof bolting, mechanized equipment can be worked close to the face, due to the absence of bulky supports. In addition to permitting wide openings and clearances, roof bolting also improves ventilation . . . minimizes the need for storage space . . . eliminates fire hazards.

Bethlehem Headed Roof Bolts In 3 Diameters

To meet virtually every roof condition, Bethlehem makes headed roof bolts in 3 diameters: $\frac{5}{8}$ in., $\frac{3}{4}$ in., and $\frac{7}{8}$ in., having typical breaking loads of from 24,000 lb for the $\frac{5}{8}$-in. bolt to 45,000 lb for the $\frac{7}{8}$-in. bolt.

If you'd like to know more about roof bolting, write us at Bethlehem, Pa., and we'll have a representative call at your convenience.

SLOTTED BOLTS, TOO. For use in certain types of rock, Bethlehem also makes a 1-in. slotted roof bolt, which is used with a steel wedge. Ask for details.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Only a 50% Grounding Wire gives 100% protection

—And Anaconda's flat 50% Grounding Wire offers full electrical protection with small diameter!

To get full electrical safety protection it is necessary to have a full 50% grounding wire. Anaconda Shuttle Car Cable gives you that—and much more!

The Anaconda *flat* 50% wire offers an extra safeguard . . . it will not cut insulation if cable is crushed by runovers.

NEW FLAT STRANDING of grounding conductor prevents broken wires—assures continuity of operation. Full 50% wire delivers maximum electrical protection.

Millions of feet of Anaconda Shuttle Car Cable have been sold without a single reported failure of grounding conductor.

The flatness of Anaconda's cable is important, too: better reeling, more cable on a reel!

4 REASONS WHY ANACONDA IS THE MOST ECONOMICAL CABLE YOU CAN BUY!

1. The only cable with rugged high-grade *neoprene insulation* that greatly increases resistance to puncture, flame and crushing.

2. Patented nylon breaker strip that reduces short circuits.

3. Improved stranding of ground and power conductors that increases flexibility and prevents broken wires.

4. Nylon seine twine jacket reinforcement prevents wicking of moisture, gives jacket greater tear resistance.

The Man from Anaconda or your Anaconda distributor will be glad to give you full information. See him today. Or write: Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.

58218

LIVE BETTER ELECTRICALLY

SEE THE MAN FROM **ANACONDA®**

FOR **SHUTTLE CAR CABLE**

NEW FLEXIBILITY...

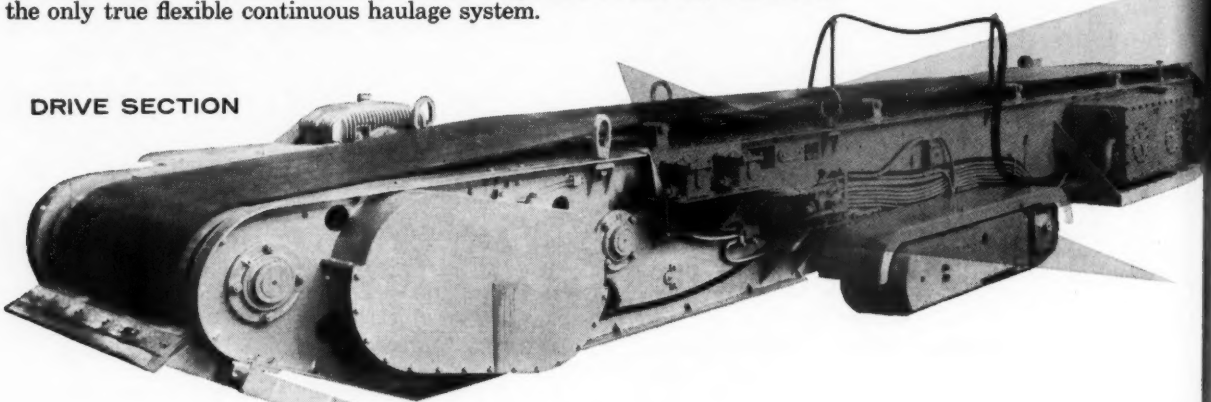
THE NEW JOY 36" EXTENSIBLE

CAPACITY UP TO 11 TONS / MINUTE

This new 36" Extensible Belt was designed to keep pace with Joy's high capacity Twin Borer Miner. Hauling its load at 500 feet per minute, the Joy XB-36 carries higher tonnage than any belt of its kind. The belt can be extended while operating—an exclusive feature with all Joy extensibles. This means that even the highest capacity continuous-type miners can now be used to best advantage—and never get ahead of the haulage system.

Higher capacity is combined with new flexibility. A new tail section swivels up to 90° in relation to the belt . . . extends the effective working radius of the tail to 15 feet without disturbing belt alignment. This feature, plus Joy 90° Belt Turns with additional live belt storage makes the Joy Extensible the only true flexible continuous haulage system.

DRIVE SECTION

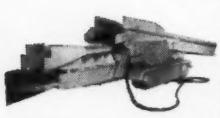


TEAM-MATE TO THE JOY TWIN BORER

here's how the team works to provide continuous mining and continuous haulage:

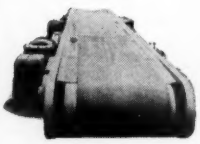
TWIN BORER . . . Full-face continuous miner of 8-tons-a-minute capacity with peaks up to 10 tpm. Mines coal from the face and loads it onto . . .

BRIDGE CONVEYOR . . . Connects Miner and Extensible Belt regardless of their position. One end supported by ball joint on tail of Miner which permits a 65° swing to either side. Other end rides on rails mounted on . . .



TAIL SECTION . . . Crawler mounted; advances with the Miner to extend the belt. Exclusive swiveling tail pulley permits the tail section to turn 90° off center, while belt remains in line with . . .

INTERMEDIATE SECTION . . . Formed by adding Limberoller idlers under the belt as the Miner and tail section advance. Simple "bed frame" sections hook together without bolts. Famous Limberoller idlers give perfect troughing, training and cannot harm belt.

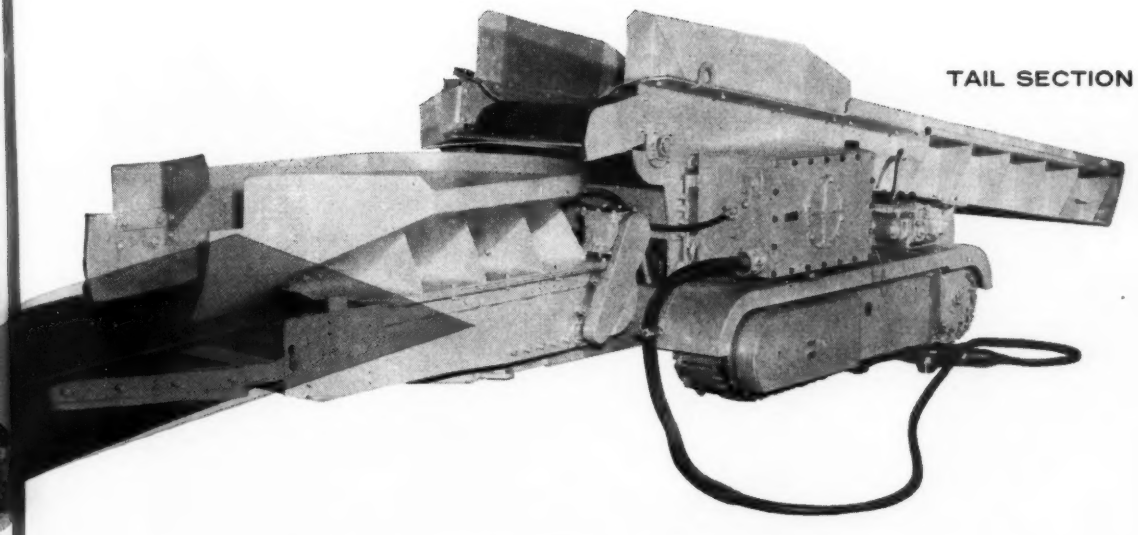


DRIVE SECTION . . . Stores the belt—controls tension and drives the conveyor. Completely self contained—requires no additional devices to store or add belting. Stores up to 200 feet of belt for 100 foot advance.

WSW CL 7312-255

HIGHER TONNAGE

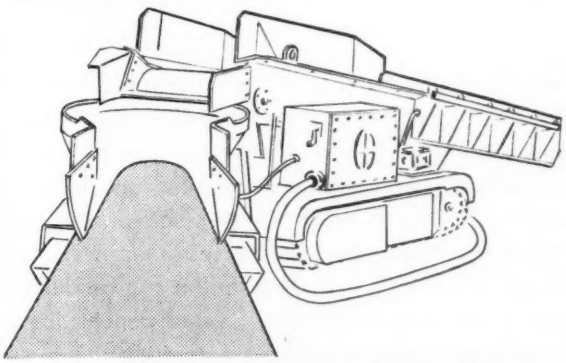
BELT CONVEYOR



TAIL SECTION

TAIL PULLEY SWIVELS 90°

The secret of the XB-36's new flexibility lies in Joy's exclusive improved tail section. Regardless of the position of the tail section, the tail pulley remains square with the belt. The tail pulley is mounted in an independently swiveling hopper with long sideboards. Vertical rollers in the framework guide the belt and keep it in perfect alignment, even though the tail section is turned as much as 90° off center. This system protects the belt from damage and permits the tail section to advance while the belt is running.



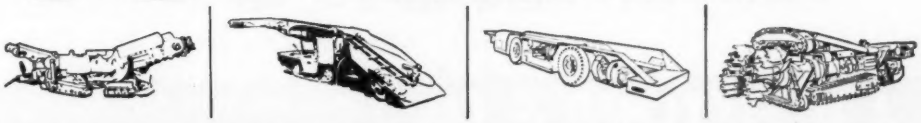
Joy Ex-Belts are successfully being used for highwall recovery, for driving entries, for driving rooms 45° and 60° from panel entries, or 90° using the block system. Consult a Joy engineer about using a Joy Extensible Belt in your operations. **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.

Write for Free Bulletin 255-3

AC

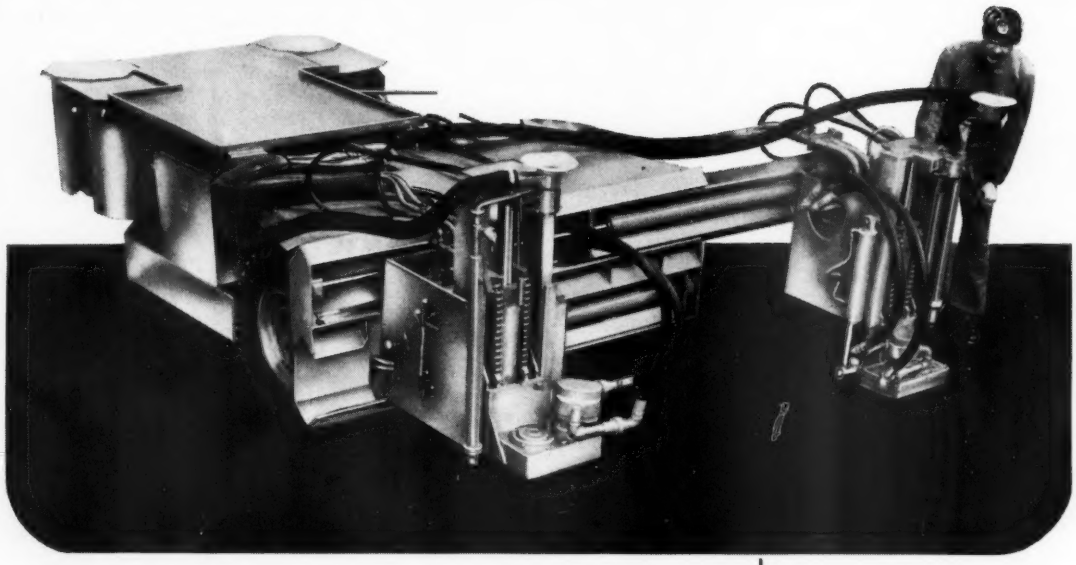
All Joy coal mining equipment, including the new XB-36, is available with AC or DC.

JOY ...EQUIPMENT FOR MINING



CONTINUOUS MINERS, MOBILE LOADERS, SHUTTLE CARS, COAL CUTTERS, CUTTING MACHINE TRUCKS, COAL DRILLS, CONVEYORS, TIMBER SETTERS, SHUTTLE CAR ELEVATORS, BELT FEEDERS, FANS, BITS, PORTABLE BLOWERS, COMPRESSORS, ROCK DRILLS, HOISTS, CORE DRILLS

FLETCHER DUAL DRILLS with Automatic Feed Control



LATCH DOWN the feed and rotation levers on this Fletcher Model DJ drill — *turn your back on it* — and it will drill a full-depth hole through roof that varies from soft shale to hard sandstone *faster and more efficiently than the best-trained drill operator.* Speed drops and thrust increases when it hits sandstone — instantly — before the bit can be dulled — and thrust drops while rotation and penetration rate increase as softer material is entered.

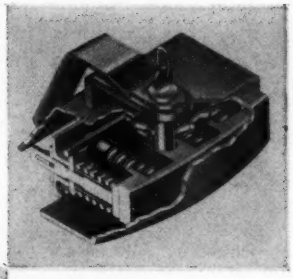
Fletcher
ROOF CONTROL DRILLS

The Results?

- **More bolts installed per shift!**
- **More footage per bit — so lower bit cost!**
- **Every operator gets top results because no experience or "feel" is required!**

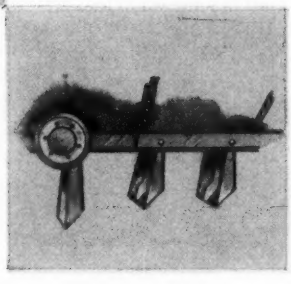
Check with your Fletcher field man on the Model DJ — or any of the many other Fletcher designs. You'll quickly discover *why more Fletcher Drills are in service than all other rotary drills combined!*

J. H. FLETCHER & CO. | P. O. Box 2143, HUNTINGTON 18, WEST VIRGINIA
JAckson 5-7811



acf **DOUBLE-ACTION SPRING BUMPER**

acf **WELDED END SILL MEMBER**



acf **LUBRICATED DROP-BOTTOM DOORS**

acf EXTRA-PERFORMANCE COMPONENTS
increase haulage efficiency

acf
LOAD SUPPORT WHEELS

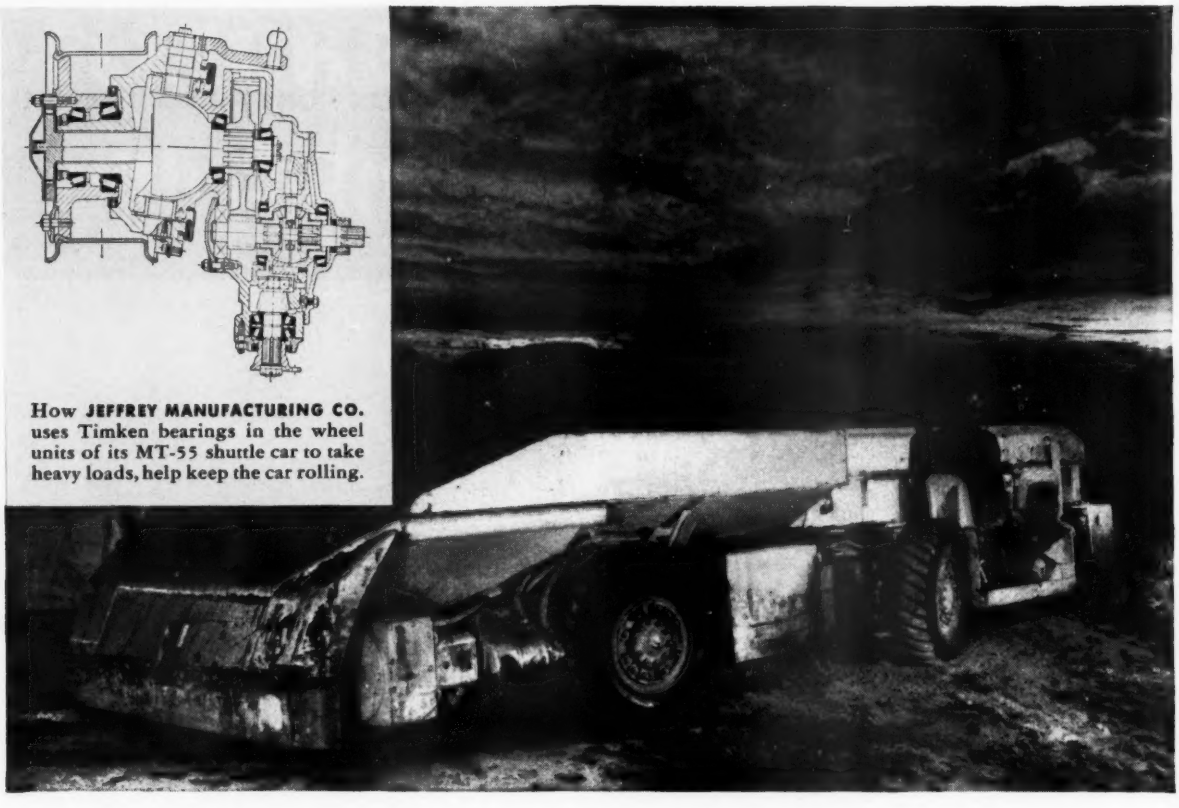
Every acf Constant Haulage Mine Car—drop-bottom, end dump, or rotary dump—pays off in extra productivity, lower maintenance costs. No matter what type or size your operations need, from 20 to 30 tons or more, there's a service-proved acf design that's right for the job. Why not discuss your haulage problems with an experienced acf representative. Just contact the nearest acf sales office or write department MC-10.

Write for this bulletin describing all types of acf *Mine Cars available on request.*

acf
AMERICAN CAR AND FOUNDRY
DIVISION OF ACF INDUSTRIES, INCORPORATED
750 THIRD AVENUE, NEW YORK 17, N. Y.

MINE CARS FOR CONSTANT HAULAGE.

SALES OFFICES: New York • Chicago • Cleveland • Washington, D. C. • Philadelphia • San Francisco • St. Louis • Berwick, Pa. • Huntington, W. Va.



How **JEFFREY MANUFACTURING CO.** uses Timken bearings in the wheel units of its MT-55 shuttle car to take heavy loads, help keep the car rolling.

Shuttle car takes the coal—Timken® bearings take the heavy loads—up, down and sideways

THE Jeffrey MT-55 shuttle car must take heavy shock loads when the loaded car hits a chuck hole at full speed on bumpy, uneven mine floors. To take the heavy loads from all directions, help assure dependable performance, Jeffrey Manufacturing Co. uses a total of 26 Timken® tapered roller bearings in the car's wheel drives and conveyor drives.

Rollers and races of Timken bearings are case-carburized to have hard, wear-resistant surfaces and tough, shock-resistant cores. The tapered design of Timken bearings lets them take *both* radial and thrust loads in all combinations. Full-line contact between rollers and races gives Timken bearings *extra* load-carrying capacity. Bearings last longer, hold gears and running parts in position.

Because Timken bearings keep housings and shafts concentric, they make closures more effective. Dust, dirt and moisture stay out. Lubricant stays in. Maintenance is reduced.

And the car starts and rolls easier because Timken bearings practically eliminate friction. They're geometrically designed and precision made to roll true. To further insure quality, we even make our own electric furnace fine alloy steel. No other American bearing maker does. So to get your No. 1 bearing value, always specify bearings trademarked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD

another continuous mining advance . . . newest

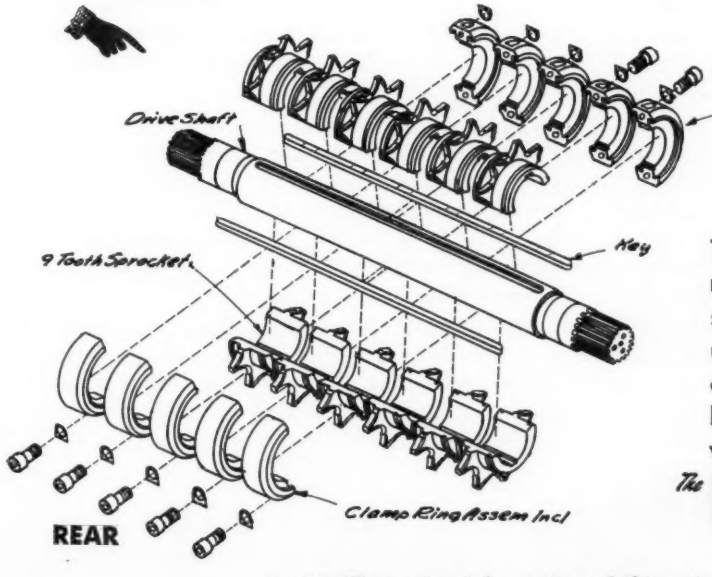
Bowdil MULTI-BAR RIPPER HEAD

IMPROVED

special hard-surfaced Wearing Shoes used in heads of the Cutterbars eliminate maintenance on roller and bearings as formerly used.

REAR OF THE RIPPER HEAD FRAME

Sprockets are clamped to an oversize Shaft, locking Shaft and Sprockets into an integral unit equivalent in strength to a 9" diameter Shaft . . . completely eliminating deflection, the chief cause of bearing failure.



ADJUSTABILITY

Each Cutterbar is independently and easily adjusted thru side ports, making it possible to retain equal tension on all chains at all times.

INTERCHANGEABILITY

All chains are similar in kerf and lacing arrangement for interchangeability as desired. All sprockets are also interchangeable. Chains may be run with or without renewable liners in the Cutterbars to suit your conditions.

RIPPER HEAD ASSEMBLY

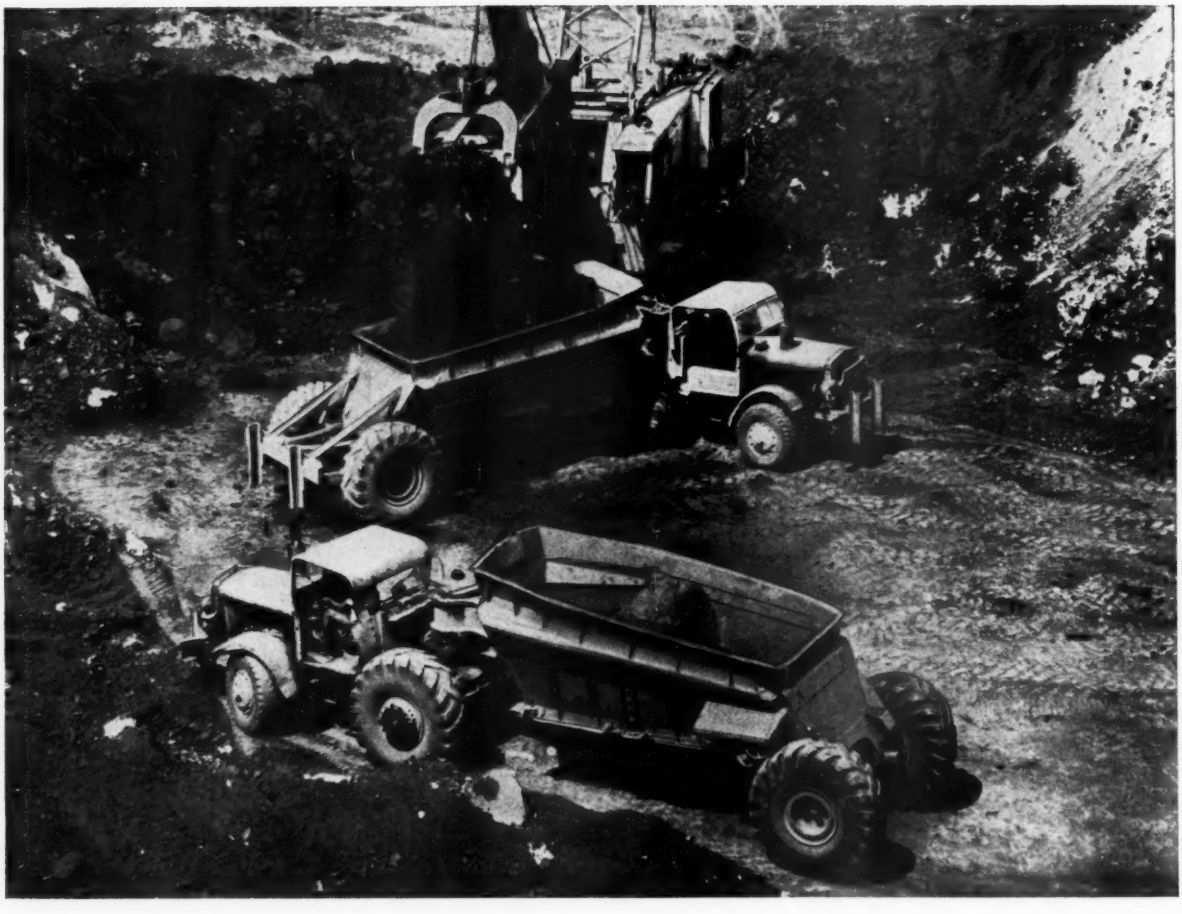
includes a special improved design Head Drive Shaft and Sprocket Assembly which makes it possible to renew a sprocket IN MINUTES without removing the Shaft . . . two-piece sprockets, held on the Double Keyed Shaft by special design Resilient Clamping Collars, maintain extreme tension to the Shaft.

► **DEPENDABILITY**

This design MULTI-BAR RIPPER HEAD is made from high grade alloy heat-treated steels. It has been, like all Bowdil products, thoroughly tested under severest conditions over a long period of time before announcement. This is in keeping with the standards of

The **BOWDIL COMPANY**
CANTON 1, OHIO

► *For illustrative information of this unit, write or call the factory: GLendale 6-7176*



5 years of dependable performance at big bauxite mine in JAMAICA

The mining and export of bauxite ore for the production of aluminum is a major industry in Jamaica . . . one that is making an important contribution to the economic progress of this historically famous Caribbean island.

Reynolds Jamaica Mines Ltd. is one of the largest operations, shipping over a million tons of ore annually to plants of Reynolds Metals Co. in the United States. The red ore is loaded by big diesel power shovels into a fleet of 15 Euclid haulers — eight Bottom-Dumps of 15 cu. yd. capacity, and 7 Rear-Dumps that carry 22-ton payloads.

Hauls from the pits to the stockpile area are up to 7000′ in length — over marl-base roads cut through the tropical country — with adverse grades up to 6%. The "Eucs" make the one-way haul in an average of six minutes and work around the clock on a 3 shift 5 day week operation to feed the kilns and 6 mile overhead tramways to the ship docks in Ocho Rios.

The Euclid fleet has been on this continuous, rugged operation for 5 years and has maintained full production requirements. Excellent maintenance, combined with the built-in dependable performance of Euclid design, has resulted in very high machine availability for Reynolds Jamaica Mines.

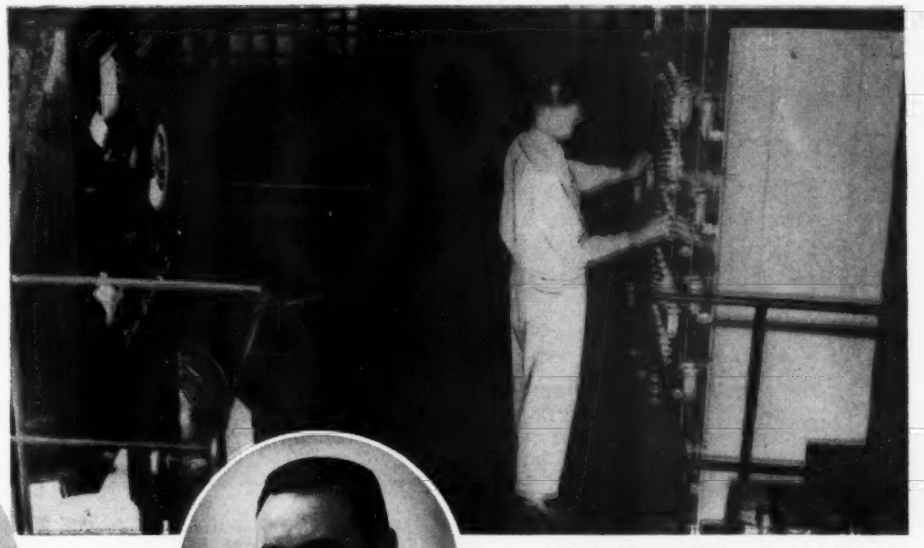
For helpful facts and figures on how Euclid equipment — rear-dumps, bottom-dumps, scrapers and crawler tractors — can cut costs on your mine, quarry or construction jobs, contact the Euclid dealer in your area or write:

Engineered to fit the job . . .
Euclids are your best investment

GM GENERAL MOTORS EUCLID

EUCLID
Division of General Motors Corporation
Cleveland 17, Ohio

Leaders of the Coal Industry confirm that H & P Fine Coal Preparation Plants need only ONE operator



H & P Control Center. Central location gives the single operator simplified control of the coal preparation plant.

C. E. WALKER
Jewell Ridge Coal Corporation

N. T. CAMICIA
Island Creek Coal Company

Modern coal cleaning methods have lifted the Coal Industry above the level of guess work. The scientific, controlled approach raises the standards of coal preparation, benefiting coal producers and coal users alike. Heyl & Patterson has contributed to this progress through new machinery and new methods. Now, a third dimension has been added by designing push-button controlled Fine Coal Preparation Plants requiring only a single operator. Obviously, great economies result from this combination of carefully engineered lay-out and properly applied equipment.

Mr. N. T. Camicia, Vice President and General Manager of Operations, Island Creek Coal Company, confirms that his 140 TPH Fine Coal Preparation and Thermal Drying Plant at Bradshaw #6 Mine, runs smoothly and efficiently with one man at the controls.

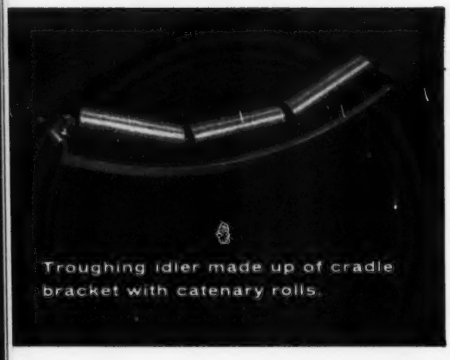
Mr. C. E. Walker, Executive Vice President of Jewell Ridge Coal Corporation, has the same experience at Melville #9 Mine, washing 80 TPH.

Among other Fine Coal Preparation Plants built by Heyl & Patterson and requiring only one operator are Hampton #3 Mine of the Westmoreland Coal Company, which has a capacity of 150 TPH, and Blue Bird Coal Company's #8 Mine, which handles about 70 TPH.

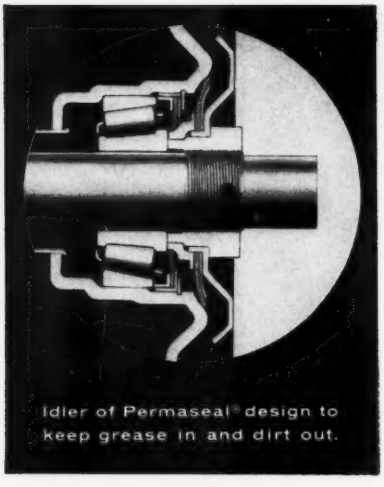
For complete information, call in an H & P Contracting Engineer, or request bulletin 557.

Heyl & Patterson INC.

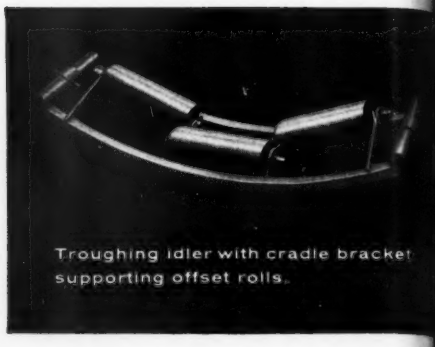
22 FORT PITT BLVD., PITTSBURGH 22, PA. COURT 1-0750



Troughing idler made up of cradle bracket with catenary rolls.



Idler of Permaseal® design to keep grease in and dirt out.



Troughing idler with cradle bracket supporting offset rolls.

To get extra value—cut operating costs

JEFFREY BELT CONVEYORS

(Wire Rope Type)

have these advantages...

Low first cost—Easy and economical to set up with fewer parts; need no belt training idlers; intermediate sections require no cover plates; two parallel wire ropes replace heavy rigid type angles or channel side frames.

Low operating cost—Fewer components to handle or transport saves time in extending or retracting belt conveyors; means less clean-up time because troughing contour of belt prevents spillage.

Movable and flexible—The lightweight design makes it easy to quickly extend or retract conveyor. Idlers can be moved or changed to suit material or mine condition. It's a simple task to change spacing of troughing idlers and stands carrying return idlers.

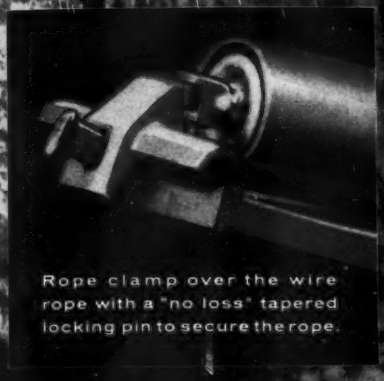
Long belt life—Lasts longer as load impact is absorbed by spring effect of wire ropes when load passes over troughing idlers.

Permaseal® idlers—Have Timken tapered roller bearings protected by two flexible diaphragm seals. Inner seal retains lubricant. Outer seal keeps out dirt. Permaseal idlers prelubricated for years of maintenance-free service.

Rope clamp for cradle bracket—Rope clamps with "no loss" tapered locking pins prevent creeping. The two parallel wire ropes are supported and spaced by strong, lightweight stands placed at intervals of approximately 20'. Cradle brackets and support stands hold ropes parallel. No separate spreader required.

Versatility—These conveyors can be used above or below ground to handle coal, salt, gypsum and iron ore. Idler rolls mounted in a cradle may be of the offset type, which permits removing or replacing individual rolls or of the catenary type. The catenary rolls are in line and connected by rivet chain links. This hinged joint arrangement causes the belt to take a troughing contour to suit heavy or light loads. Full width return rolls are used.

Send for bulletin 948 for more details. The Jeffrey Manufacturing Company, 958 North Fourth Street, Columbus 16, Ohio.



Rope clamp over the wire rope with a "no loss" tapered locking pin to secure the rope.

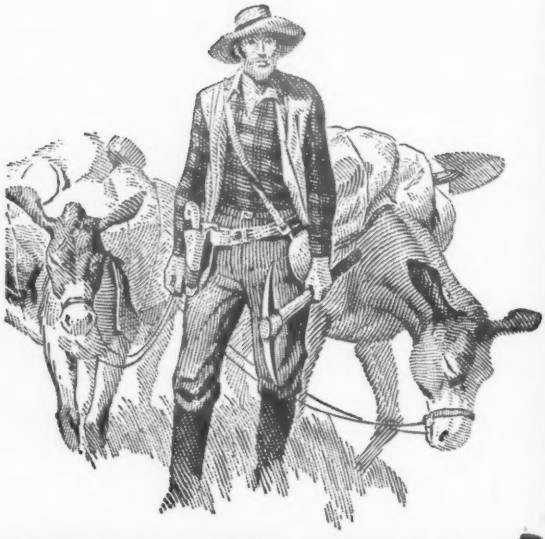
A 150-foot extension can be extended or retracted in less than an hour... no loss of production time with between-shifts extension of Jeffrey belt conveyor.

JEFFREY

MINING • CONVEYING • PROCESSING EQUIPMENT...

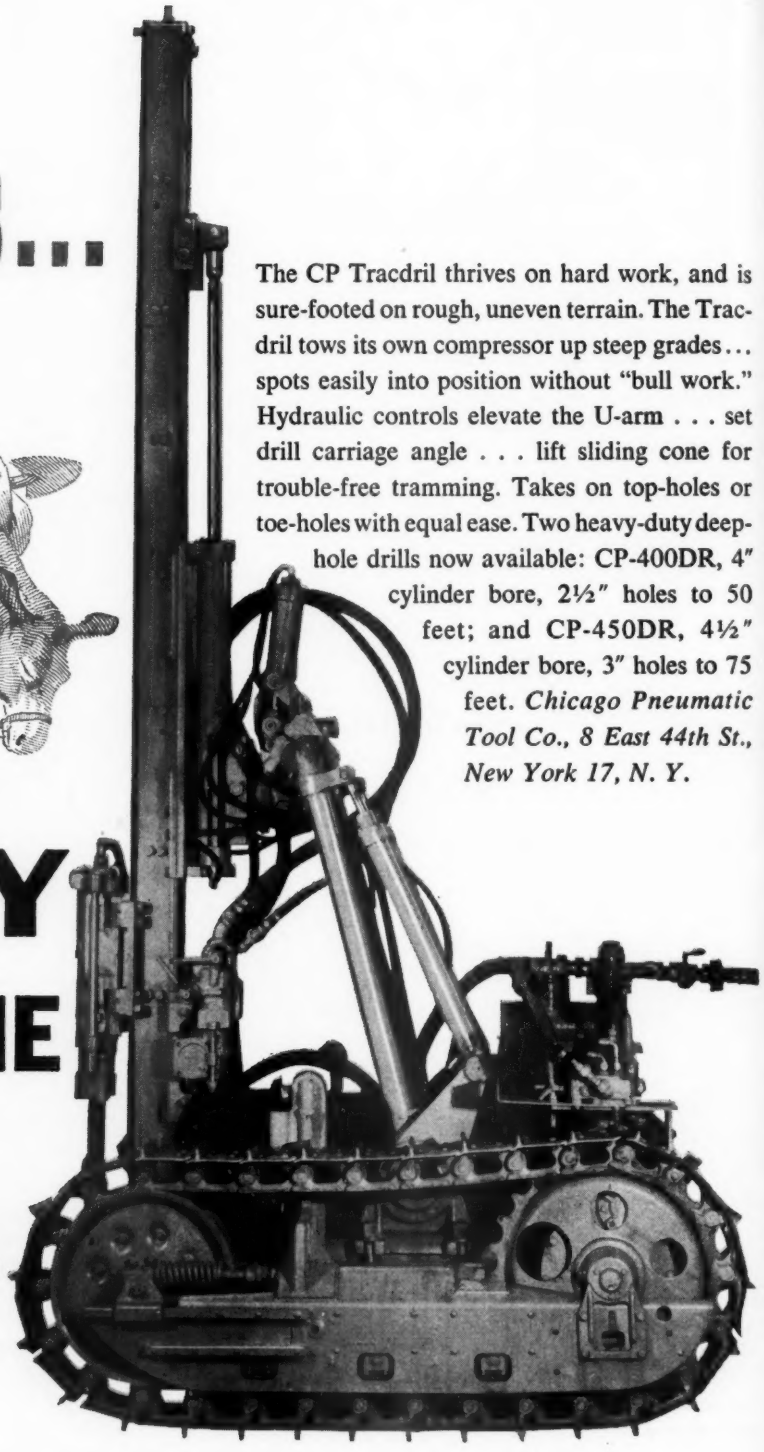
TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

Miner's best friends...



The CP Tracdril thrives on hard work, and is sure-footed on rough, uneven terrain. The Tracdril tows its own compressor up steep grades... spots easily into position without "bull work." Hydraulic controls elevate the U-arm . . . set drill carriage angle . . . lift sliding cone for trouble-free tramming. Takes on top-holes or toe-holes with equal ease. Two heavy-duty deep-hole drills now available: CP-400DR, 4″ cylinder bore, 2½″ holes to 50 feet; and CP-450DR, 4½″ cylinder bore, 3″ holes to 75 feet. *Chicago Pneumatic Tool Co., 8 East 44th St., New York 17, N. Y.*

TODAY IT'S THE CP TRACDRIL

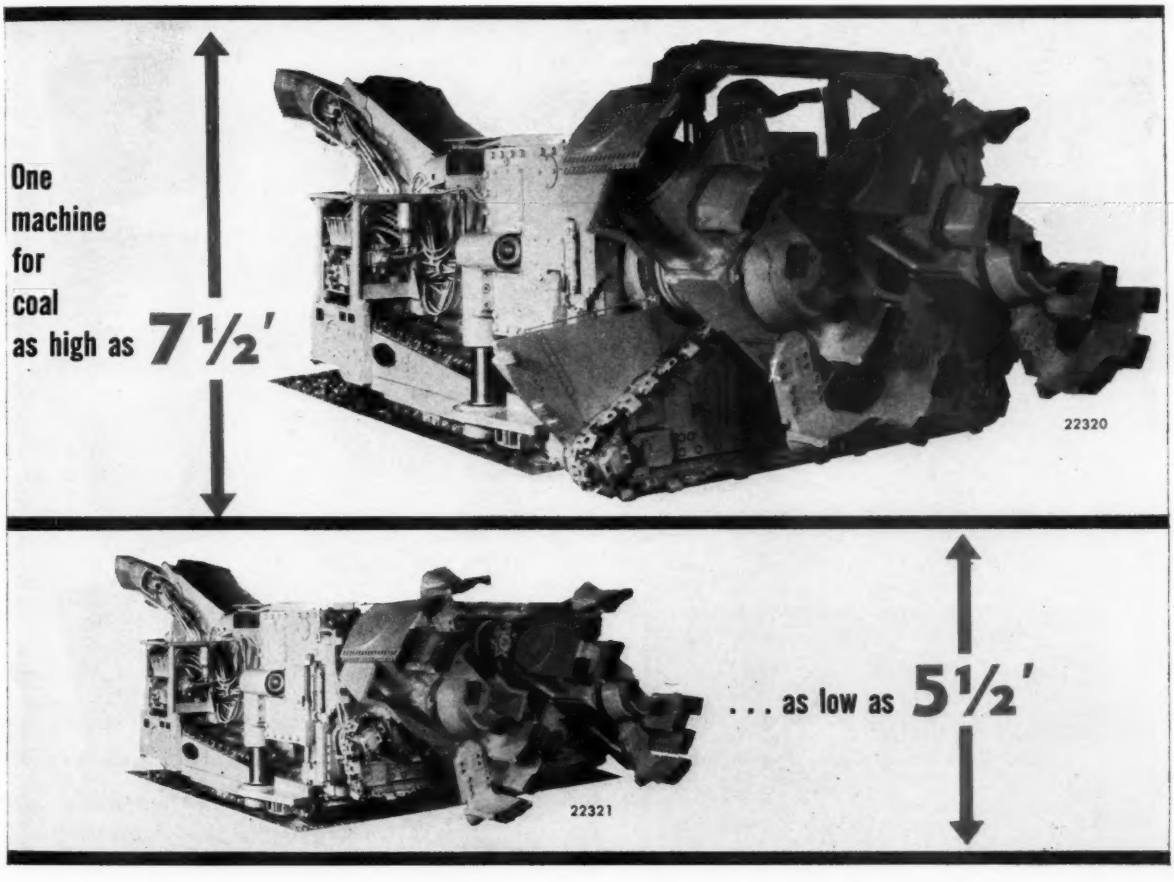


Chicago Pneumatic

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

NEW! "Variable Mining Height" Continuous Borer

GOODMAN TYPE 425



Here's the *newest, most versatile and powerful* continuous mining machine on the market today for profit-boosting tonnages and cost cutting performance.

Now, one machine can be utilized for full-face mining at any height from 7½' down to 5½' . . . and the mining height can be varied as the machine advances.

The 425 is an exceptionally rugged machine that combines capacity with a flexibility of movement that suits it to all phases of development, room, and pillar recovery work. All movements are powered by a single 250 h.p. Goodman AC or DC motor.

Call in your Goodman Sales Engineer for the full story.

GOODMAN
MANUFACTURING COMPANY
Halsted Street and 48th Place, Chicago 9, Illinois

CUTTING MACHINES • CONVEYORS • LOADERS
SHUTTLE CARS • LOCOMOTIVES • CONTINUOUS MINERS

"For continued leadership in machines for continuous mining—look to Goodman"

All around . . . underground . . . GARDNER-DENVER keeps production stepping

In blast hole drilling . . .

DEEP HOLE DRILLS—developed especially for the job. Some mine properties report breakage costs reduced as much as 75% using Gardner-Denver deep hole drills.

DRIFTERS—a choice of hammer diameters from 2¾" to 4½", with feeds and controls for drilling in any type of rock. Outstanding in hole-cleaning ability, air economy and drilling speed.

AIR FEED LEG DRILLS—lightweight drilling combination designed for ease of operation. Controls are grouped on drill backhead. Two models: FL48 and FL58.

SINKERS—a complete line. Lightweight models for secondary breakage and heavy-duty drills for shaft sinking.

STOPERS—Three rugged models. All available in your choice of feeds, controls and chuck construction.

In quality drill steel . . .

SECTIONAL DRILL RODS—highest quality . . . shot-peened and carburized to stand the down-the-hole gaff longer.

RING SEAL SHANKS—replace old-type water swivels without adding additional length to drill.

COUPLINGS—extra long, extra hard threads for longer drilling life.

In mucking operations . . .

MINE CAR LOADERS—four rugged, high-capacity loaders with fast action and plenty of mucking power. Models to meet various headrooms and car sizes. Safe, easy to use . . . have low center of gravity.

"AIRSLUSHERS"—three Gardner-Denver load-lugging slusher hoists available. Powered by high-torque, five-cylinder radial air motors. Motor and drive completely enclosed to keep out dirt and water.

In jumbo drilling setups . . .

HYDRAULIC DRILL JUMBOS—rail-mounted jumbo units with one, two or three booms, in your choice of drills and feeds.

JMT "MOBILJUMBO"®—a self-propelled, push-button drilling unit. Available with two or three booms . . . with drills and feeds to suit your ground.

JUMBO COMPONENTS—build your own jumbo with Gardner-Denver drills, feeds, hydraulic booms, remote controls and drill positioners. A combination for every drilling need.

With air power . . .

ROTARY PORTABLE COMPRESSORS—five sizes, wheel- or skid-mounted.

STATIONARY WATER-COOLED COMPRESSORS—single- and two-stage units in capacities to 1854 cfm.

Plus . . .

Bit Grinders • Centrifugal Pumps • Grout Pumps • Air Hoists • Columns • Drill Steel Shapers and Sharpeners • Sump Pumps • Maintenance Tools • Oil Forges • Air Line Oilers • Air Motors

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

Export Division, 233 Broadway, New York 7, New York
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

with ESCO
Cast 12M Points and Adapters

1 ONE-SOURCE SAVINGS—*ESCO* Points and Adapters are quickly available for *every digging tool* from your *ESCO* dealer. By using *ESCO* Points and Adapters on *all* your digging equipment you can reduce your point inventory, save ordering time and consolidate purchases for additional savings.

2 INCREASED YARDAGE—*ESCO* Points and Adapters step up production because they are scientifically engineered. Digging angle, in relation to bucket lip, is carefully calculated for maximum digging efficiency. Points are self-sharpening. There are seven point shapes to choose from.

3 POINTS OUTLAST ALL OTHERS—Because *ESCO* Points and Adapters are *cast* there is extra metal where it counts: at the wear points. *ESCO* 12M alloy steel has outstanding abrasion resistance and shock-absorbing toughness. Heat treating, differential hardening add extra-long life.

4 REDUCED DOWNTIME — Quick-change design of *ESCO* Points permits removal and replacement of four points in five minutes without special tools.

No other manufacturer offers such a complete selection. See your ESCO dealer for details today.

ESCO

ELECTRIC STEEL FOUNDRY COMPANY
2188 N. W. 25TH AVE. • PORTLAND 10, OREGON
MFG. PLANTS AT PORTLAND, ORE. AND DANVILLE, ILL.
Offices in Most Principal Cities
ESCO INTERNATIONAL, NEW YORK, N. Y.
IN CANADA *ESCO* LIMITED

How rubber-tired mobility speeds pit production — increases profit

Only a rubber-tired tractor can readily travel from job-to-job in your pit or plant operations. It runs at speeds to 17 mph, shuttles fast between shovel clean-up and other assignments. The operator just shifts into high gear and your tractor is on its way, via haul road or across the pit floor to its next job, whether to strip overburden, level stockpiles, tow other equipment, or switch railroad cars.

Larger pit areas, and higher production requirements, make it necessary to have equipment that can move around fast and easy on its own power.

So the need for high-speed mobility is increasing each year, while the time and cost of moving track-type equipment designed for limited area work becomes higher and higher, cutting profits more and more.

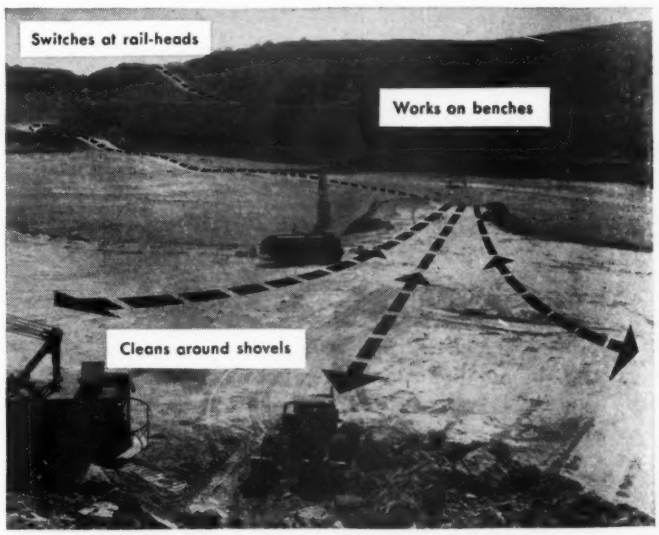
In the light of these developments, it will pay you to consider the importance of *mobility* as a necessary tractor requirement in your pit operations.

Rubber-tired tractor travels at speeds up to 17 mph on work-and-run assignments. Operator can drive over pit floors, or off road. He can road his machine over tracks, ties, switches, and paving, without damage.

Get all 4 . . . power, traction, speed and mobility . . . with Tournatractor®

Tournatractor is a modern tractor designed to provide ample *power, traction, speed* and *mobility* for scattered pit operations. It does not offer as much drawbar horsepower at speeds below 2 miles per hour as do track-type tractors of equal engine horsepower. But for pit operations where you *can* capitalize on *speed* and *mobility* — we suggest you consider the *new* Tournatractor. The cost is 10% below that of track-type tractors with torque converters and comparable engine horsepower . . . and maintenance costs are lower.

There's a bonus-value for you in today's improved Tournatractor. A railroad coupler attachment is now available, converts this machine quickly to a practical SwitchTractor*. With coupler at one end, and dozer at the other, unit does double-duty . . . makes it an even more profitable tool for your pit operations. Your Le-Tourneau-Westinghouse Distributor will be happy to arrange a demonstration of a Tournatractor in your pit, to prove that its special work advantages — *speed* and *mobility* — can pay real dividends for you. Ask him now . . . or write the factory.



Sketched lines show range of rubber-tired tractor in typical mine. In foreground, tractor cleans-up around shovel. It ranges over entire pit floor for dozing, and on benches bordering the pit. Rail-head is only a few minutes drive away for switching work.

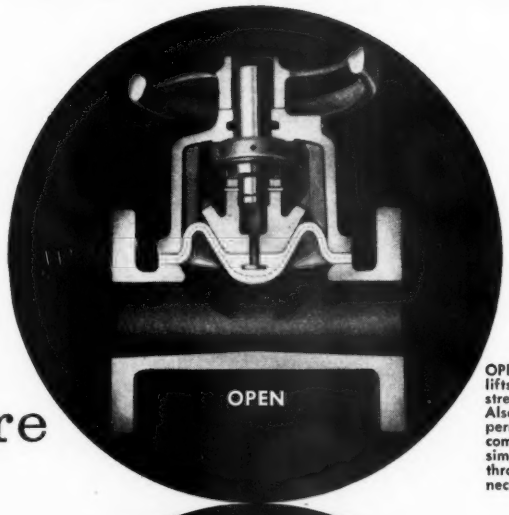
*Trademark CT-1614-M-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

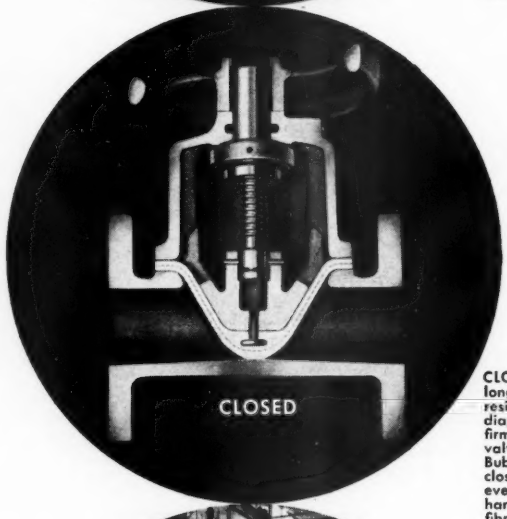
A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

Maximum flow, minimum turbulence, negligible pressure drop!



OPEN Diaphragm lifts high for streamline flow. Also, valve design permits comparatively simple rodding through, when necessary.



CLOSED Despite long usage, resilient diaphragm seals firmly against valve body. Bubble-tight closure is assured, even when handling gritty or fibrous materials.

GRINNELL-SAUNDERS STRAIGHTWAY DIAPHRAGM VALVES* are unsurpassed for handling viscous materials — semifluid foods, latex, magmas; solids in suspension — slurries, pulp stock, sludges; fluid-borne abrasives; corrosive chemicals.

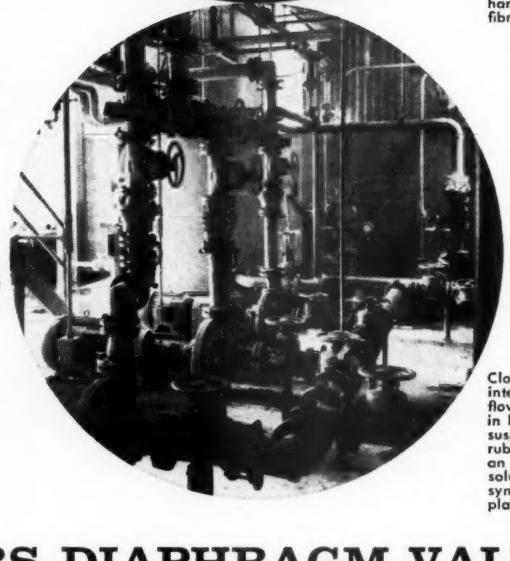
The straight-through design eliminates pockets, gate trenches and other obstructions which can trap solids. The result is maximum flow, minimum turbulence, and negligible pressure drop for a diaphragm valve.

The straight-through design also has the advantage of causing very little basic change in the direction of the fluid stream, thus reducing abrasive action from high velocity particles.

These advantages are in addition, of course, to benefits normally associated with the use of diaphragm valves . . . such as freedom from corrosion and clogging of working parts, since these are completely sealed off by the diaphragm; prevention of product contamination; elimination of stem leakage and routine maintenance, because there are no packing glands. Also, when properly pitched, lines are self-draining.

Grinnell-Saunders Straightway Diaphragm Valves are available in a choice of body sizes and materials, linings and diaphragms. Handwheel or power operated. For complete information, write Grinnell Company, Inc., 277 West Exchange St., Prov. 1, R. I.

*Patented



Clogging and interruption to flow is prevented in lines handling a suspension of rubber particles in an acid brine solution at this synthetic rubber plant.

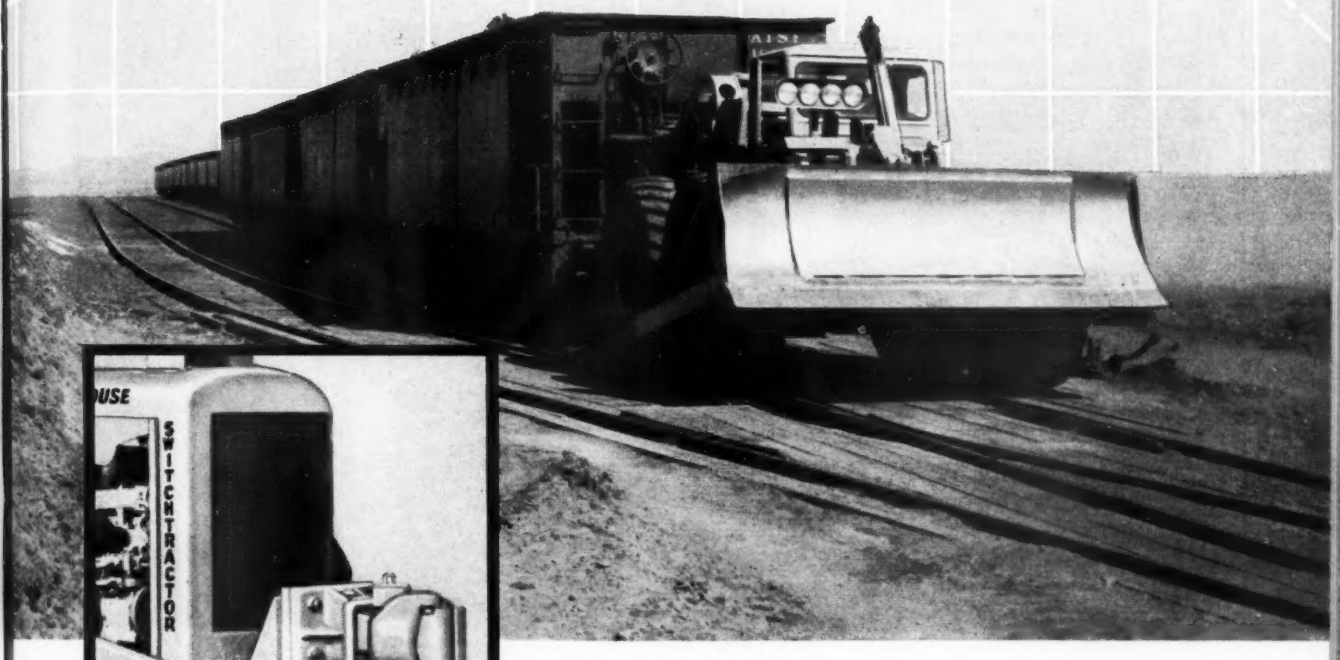
GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

Change the trend of your pit costs

with double-duty L-W SwitchTractor†



SwitchTractor's coupling is an American Association of Railroads Standard "E" top-operating type, on a 6"x6" shank with 19" knuckles. L-W tractor can safely handle 5 loaded, or up to 18 empty rail-cars. With dozer blade — one of the ten multi-service attachments — go-anywhere tractor economically handles pit maintenance, and construction assignments.

This single, speedy LeTourneau-Westinghouse SwitchTractor may be sufficient to handle all your tractor dozing, and RR car switching jobs. You can then eliminate two or more expensive, specialized machines — as well as the manpower to operate and service them. Result: you lower operating costs . . . and increase profits.

Go-anywhere mobility

Driving under its own power, rubber-tired, coupler-equipped L-W tractor always takes the fastest, most direct route to any job. It travels on paved roads or goes cross-country. Unit spots rail-cars fast since no on-track maneuvering is necessary. Tires flex over obstacles, won't damage switches or chamfer ties.

Moves up to 18 rail-cars

SwitchTractor's 210-hp diesel engine can move 660 tons of rolling freight up a 1% grade. It safely handles 5 loaded or up to 18 empty rail-cars. Tractor's tires straddle rails, grab tie-ends with *double* the grip of steel wheels on steel rails.

Handles widely scattered dozing jobs

When switching is completed, versatile L-W tractor speeds back to its regular clean-up and construction duties. Its electrically-operated dozer blade pushes loads up to 3 cu yd, in most materials. With 17 mph forward and 7 mph reverse speeds, tractor travels and completes widely separated dozing assignments fast.

Let us show you how L-W SwitchTractor works productively *all day long* to help you cut pit costs. Write for full details and demonstration.

†Trademark ST-1893-MQ-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

Questions

We've been asked about the Yieldable Arch

What is the Yieldable Arch?

Bethlehem's Yieldable Arch is made of U-shaped sections rolled from high-strength steel in the 95,000-105,000 psi tensile range. A typical Arch set is built up of three or more segmental lengths which nest at the overlapped ends. Heavy U-bolt clamps hold these ends together, thereby forming friction joints which will yield under excessive pressures. Normally, torque on the bolts is 180-200 ft/lb, allowing Arch to yield at about 40,000-50,000 lb.

Why is the yieldable feature important?

An arch that will yield, such as Bethlehem's Yieldable Arch, gives the overburden a chance to settle slowly into its own natural arch, which then carries the major share of the load. The more the Bethlehem Arch yields, the more the load is transferred to abutments on either side of the opening.

Rigid supports cannot uniformly distribute the dynamic pressures caused by the weight and subsidence of overburden. Sooner or later they "let go," preventing the formation of a natural pressure arch around the mine opening.

In what sizes is the Yieldable Arch available?

Bethlehem rolls two sections of Yieldable Arch: 15 lb and 21 lb per foot. The two sections have almost identical outer contours. The difference lies in the thickness, notably in the top flanges and the base. Sets can be tailor-made to fit mine openings, from a minimum of 6 ft up to 20 ft wide, depending on individual mine conditions.

Where should the Arch be used?

The Yieldable Arch is now being used in both coal and ore mines for haulage roads and drifts, slusher drifts, transfer drifts, or any opening of sufficient size where heavy ground causes spalling or squeezing conditions. This question, of course, can best be resolved by an on-the-spot discussion with a Bethlehem engineer.

What about spacing of Arch sets?

Ground conditions govern the spacing of Yieldable Arch sets, but generally speaking a spacing of 2 to 3 feet in heavy ground is about average. In any situation, the spacing should be such as to ensure that the steel, not the lagging, will do the yielding.

Speaking of lagging, just what is it and why is it important?

Lagging and packing are very important in a Yieldable Arch installation for several reasons. First, to prevent the falling of material into the opening; second, to fill the voids between mine roof and Arch sets; third, to keep the load on the Arches relatively uniform. Lagging can be poles, planks, round or split timbers, or miscellaneous lengths of cut timber. Some mines also use old steel ties and other steel "leftovers."

Does the Yieldable Arch require maintenance?

A Yieldable Arch set is, in the strict sense of the word, a machine. As such, it must be kept operable. If the load becomes evident (as, say, by a sag in the lagging) the Arch must be permitted to yield. U-bolts should be checked for binding; perhaps a blow with a hammer will correct the condition. Torque on the bolts must be properly maintained.

All in all, the Yieldable Arch is a long-service product which will perform satisfactorily with minimum maintenance. When it has outlived its usefulness in a particular location it can be recovered and re-installed elsewhere.

How about cost?

Naturally you'd expect to pay somewhat more initially for a fabricated item like the Yieldable Arch than you would for timbers or other rigid materials. But as soon as the Yieldable Arch is installed, it starts saving you money. Most mine operators who have Arch installations state that the Yieldable Arch pays for itself in remarkably short order; six months is not at all unusual. This, together with salvageability, makes Bethlehem's Yieldable Arch the most economical roof support in heavy ground.

● ***You probably have other questions of a more specific nature to which you would like answers. If so, by all means write us; we will study your questions and reply as promptly as possible.***

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

22½-ton Mack LVX

SURE WAY TO TURN A PROFIT

From the moment you start hauling ore on Macks, you'll find what mine operators the world over have discovered—that, for the utmost in economical operation and long service life, you can't beat a Mack!

Heavy-duty Mack dumpers are engineered from start to finish to handle the most punishing hauling jobs. Single-unit all welded frames that pay dividends in extra years of service and rock-bottom down time . . . outstanding economy that cuts hauling costs to the bone . . . and unmatched performance and durability that mean Macks are hauling more profit-making payloads, month after month, with time out for only routine servicing.

You get other important advantages from Mack: exclusive Mack Balanced Bogie with Power Divider, that takes you in—*and* out—of places where other trucks just can't go . . . Mack-built clutches, transmissions and differentials specially engineered to work together for the best possible performance.

Mining operators everywhere are benefiting from these Mack profit-making features. Give your Mack branch or distributor a call for the names of Mack users near you. Let them tell you about the "extras" they get from Macks—in economy, performance and long service life—that can mean a more profitable operation for you. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

MACK
first name for
TRUCKS

30-ton Mack LRSW

34-ton Mack LRVSW

15-ton Mack LRX

Lower Ton-Hour Crushing Cost

with SYMONS® CONE CRUSHERS

Here are some of the reasons why:

You can get up to 900 or more tons per hour per unit . . . Symons Cone Crushers consistently deliver large tonnages of crushed product. Positive setting and a carefully designed crushing cavity assures uniformity of product.

Operate with minimum supervision . . . Symons Cone Crushers require a minimum of man hours for installation, operation and maintenance. Adjustments for product size or liner wear are quickly made, and easy access to all parts makes servicing relatively easy and holds down-time to a minimum.

Ability to withstand rugged service . . . Symons Cones are of heavy duty, quality construction to meet the extremely tough service encountered in reduction crushing of all types of ores and minerals. All bearings are thoroughly lubricated by a pressure circulating system.

Full size range for primary, secondary or tertiary crushing . . . Symons Cone Crushers are built in eleven different sizes, ranging from 22″ to 7′ in diameter, for capacities of from 6 to 900 or more tons per hour. Available with fine, medium, coarse and extra-coarse cavities, to take feed up to 18″ or 20″. *For complete details, send for Bulletin 247.*

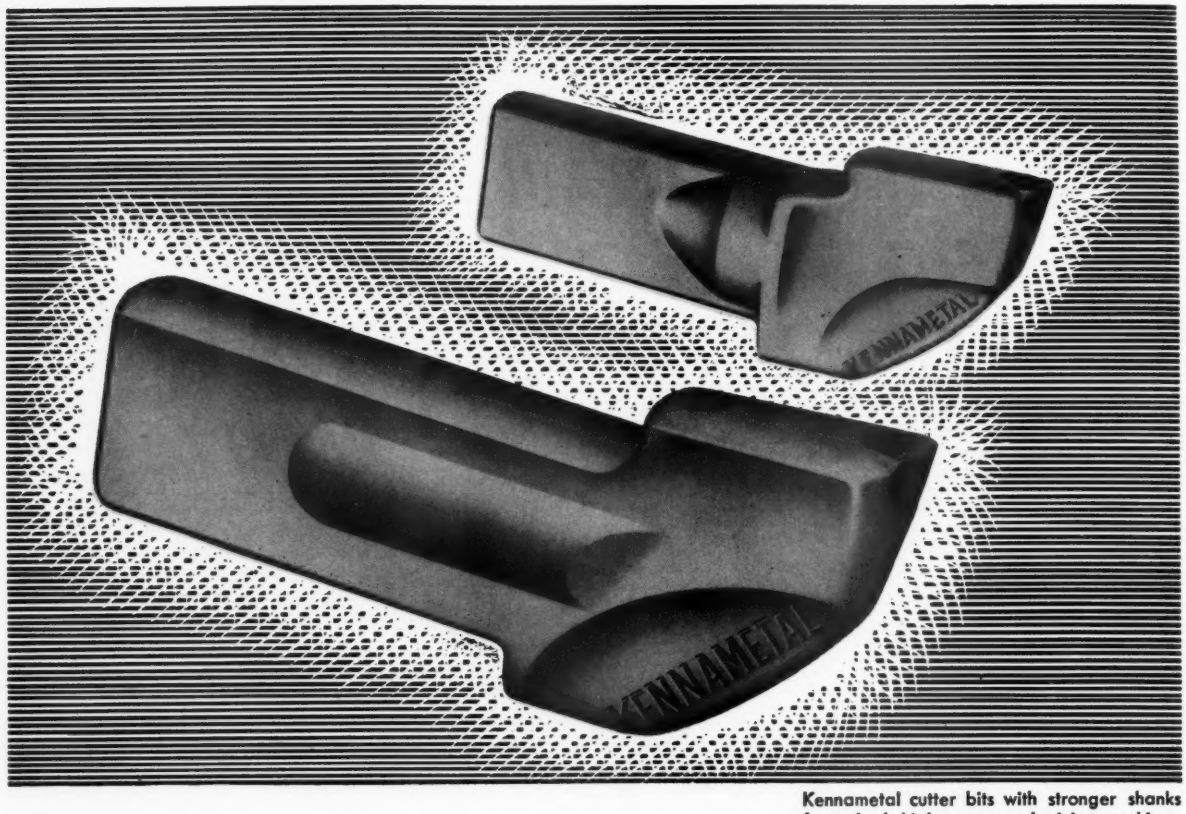
SYMONS . . . a registered Nordberg trademark known throughout the world.

NORDBERG MFG. CO.,
Milwaukee 1, Wisconsin

NORDBERG

C658

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS • NEW ORLEANS • NEW YORK • ST. LOUIS
SAN FRANCISCO • TAMPA • WASHINGTON • TORONTO • VANCOUVER • GENEVA • JOHANNESBURG • LONDON • MEXICO, D. F.



Kennametal cutter bits with stronger shanks for today's higher powered mining machines.

Next time the going gets rough...

Try these two NEW Kennametal* Cutter Bits

Using standard bit blocks, the new U7B Series, shown in the foreground above, quickly and economically reduces shank breakage in hard cutting sections. Reinforcing ribs on both sides of the shank fit the center hole of most bit block designs and provide the added shank strength required to resist side thrust.

Kennametal offers the rugged U3 Series for *extreme* cutting conditions, where hard impurities are encountered frequently and maximum bit strength is required. Special Bit Blocks to fit the U3's greatly increased cross sectional area are now available.

Actual mine testing, in problem areas, has proved that both of these bits keep cutting coal where other bits fail.

Forged from highest quality steel, the added shank cross section provides the strength required to stand up in difficult cutting areas under the high power of today's mining machines.

Get more information on the latest of "The Yellow Bits" from your Kennametal Representative. You'll find his name listed in the Classified Section of your Telephone Directory under "Mining," or write KENNAMETAL INC., Mining Tool Division, Bedford, Pennsylvania. 3188

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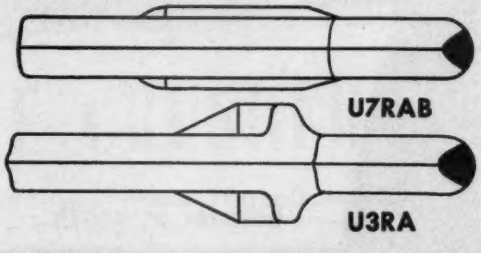

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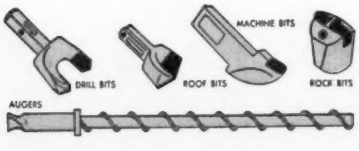

INDUSTRY AND
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EDITORIALS

ROBERT W. VAN EVERA, Editor

OCTOBER, 1958

EDITOR'S NOTE: SAMUEL LENHER, *vice president and director of E. I. du Pont de Nemours & Co., recently addressed the Tenth Annual Management Conference at Cornell University. His address concerned the public's stereotype of the personal character and work of a scientist or engineer. Mr. Lenher pointed out that certain negative concepts held by many people are often responsible for young people shying away from a scientific career—a result that is particularly disappointing because these concepts have no factual basis. We believe it is appropriate to present the following remarks from Mr. Lenher's address.*

THE SCIENTIST AS A PERSON

THE attention of the public recently has been directed, in an unusual degree, toward the American scientist. The evidence, however, of public confusion over the true nature of the scientist [or engineer] seems to me sufficiently strong to be alarming. I would like to cite some of this evidence.

In a study conducted by Drs. Margaret Mead and Rhoda Metraux for the American Association for the Advancement of Science entitled, "The Image of the Scientist Among High School Students," students in more than 120 high schools were asked to write essays on what they thought about science and scientists. Out of this study came what the authors described as three images—the shared, the positive, and the negative. Drs. Mead and Metraux concluded that "this image in all its aspects, the shared, the positive, and the negative, is one which is likely to invoke a negative attitude as far as personal career or marriage choice is concerned."

The negative image, and the extent to which it discourages young people from seeking scientific careers, is of very serious concern to all of us, and indeed, to the future welfare of the United States.

For this reason, it is important to recite some of the facets of the negative image which Drs. Mead and Metraux feel will discourage young men and women from entering science:

"If he works by himself, he is alone and has heavy expenses. If he works for a big company, he has to do as he is told, and his discoveries must be turned over to the company and may not be used; he is just a cog in a machine. He may even sell secrets to the enemy.

"His work may be dangerous. Chemicals may explode. He may be hurt by radiation, or may die. He may even accidentally kill someone.

"He may not believe in God, or may lose his religion.

"He is a brain; he is so involved in his work that he doesn't know what is going on in the world. He has no other interests and neglects his body for his mind. He can only talk, eat, breathe and sleep science.

"He neglects his family—pays no attention to his wife, never plays with his children. He has no social life, no other intellectual interest, no hobbies or relaxations. He is never home. He is always reading a book. He brings home work and also bugs and creepy things. He is always running off to his laboratory. He may force his children to become scientists also.

"A scientist should not marry. No one wants to be such a scientist or to marry him."

To call such an image unpleasant would only be redundancy. In an effort to get the facts about the scientist as a person, the Du Pont Company's personnel research unit conducted a sociological study of about half of the 2400 technically trained people who are engaged in research for the company.

Unlike the high school students' concept of the scientists, the Du Pont survey disclosed:

The scientist is not an atheist, as many believe, but a religious man. Approximately 75 percent of the Du Pont scientists listed church as important in their activities. Whereas a survey of Protestant churches showed that only one out of four members took an active part in church affairs, more than half of the Du Pont scientists reported such activity.

The scientist is a family man. In the company, 88 percent of the scientists are married, compared to 85 percent of the general adult population as reported by the U. S. census. Their average number of children per family is slightly more than two, compared to one and one-half for the average American family.

The scientist is not anti-social, but is active in civic affairs. The survey showed that 37 percent of the Du Pont scientists surveyed participated in 64 different civic activities. Nineteen percent mentioned membership in community councils or associations, and seven percent were in fund-raising groups. They hold or have held 136 positions of responsibility, such as president, vice president, board of governors, chairmen of committees, and team captains.

Contrary to much opinion, his job is not hazardous, thanks to modern safety practices. Employes at all Du Pont research laboratories established an injury frequency rate of only one man injured in 3,000,000 exposure hours during the last five years. That is 23 percent lower than the over-all company rate in the same period. It is far better than the frequency rate for all American industry which is one man injured in 160,000 exposure hours.

As to the misconception that scientists are not rewarded for their discoveries, it is true that a scientist who is paid by a big company to do research and who makes a discovery is expected to give the company the benefit of that discovery. But, if the discovery provides a commercial opportunity for the Du Pont Company, the scientist shares commensurately in the rewards.

As evidence that scientists are more than mere "cogs in a machine," it should be pointed out that 43 of the 118 top management posts in Du Pont are held by men who began as research scientists. In addition, all 24 of the directors and assistant directors of research in the company's various departments are scientists.

These facts demonstrate the scientist is a most desirable citizen engaged in an essential and rewarding profession. Instead of being "squares" or hermits, they have about the same interests as other Americans. Perhaps *because* of their intellectual training, many scientists accept even greater responsibility for civic and social obligations.

Fig. 1. Black Lake prior to 1948: Lake Asbestos' ore bodies lie under the lake shown in this photo. Partly because of this unfortunate location, plus recognition of the difficulties that would attend mining under the lake if orebodies did exist there, the immediate area covered by the lake was virtually disregarded until 1948

PROGRESS at Black Lake

By V. I. MANN
Vice President
Lake Asbestos of Quebec, Ltd.

Diverting a river . . . draining a lake . . . moving a highway . . . dredging over 26,000,000 cu yd of fine silt, organic ooze and glacial till. . . . Here's an up-to-the-minute report on the difficulties that were encountered and overcome by Asarco's Lake Asbestos of Quebec Ltd. in developing a 5000-tpd mine and milling plant.

THE deposit opened up by American Smelting and Refining Company's wholly owned subsidiary, Lake Asbestos of Quebec Ltd., is at Black Lake in the center of the Quebec asbestos district.

Prior to 1948, the site of the mine and plant was just another of the many picturesque lakes along the trans-Canadian highway. Since that date the existence of commercial deposits lying under the lake has been proved by diamond drilling and underground workings; the mine prepared for production by removal of over 26,000,000 cu yds of waste material by dredging and nearly 6,000,000 cu yds by shovels and trucks; the high-

way moved to a higher location; and a modern asbestos milling plant of 4000 to 5000 tpd capacity constructed. The plant started production on July 1, 1958.

Initial discovery of asbestos in the serpentine belt was in 1874. In 1876, the major deposit at the center now known as Thetford Mines was found. This deposit is being mined at present by the Asbestos Corp. Ltd., Johnson's Co. Ltd., and Bell Asbestos Mines Ltd. The Canadian Johns-Manville Company's Jeffrey mine at Asbestos, Que., some 40 mi southwest of Thetford, was opened in 1881 and has since been developed into the world's largest asbestos producing mine.

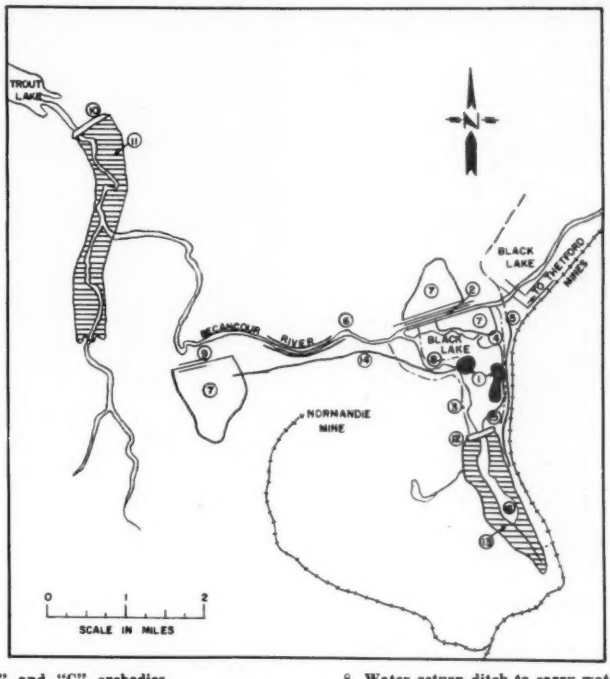
Other major companies in the district, in production for many years include Nicolet Asbestos Mines Ltd., Flintcote Mines Ltd., Quebec Asbestos Corp. Ltd.; and now three newcomers, Carey-Canadian Mines Ltd., National Asbestos Mines Ltd., and ourselves have started production this year.

Records of asbestos production date back to 1878, and the first year's production was stated to be 50 tons of fiber. With the constant increase in use and demand for asbestos fiber, mines in the Thetford district have maintained steady growth, and during the years 1955-1957 inclusive, production exceeded 1,000,000 tons per yr. Total fiber production from this district, for the period 1878-1957 inclusive is 19,383,165 short tons, having a sales value of $1,237,047,864—an average of $63.82 per ton. Average value of 1957 fiber production was $100.21 per ton.

Deposit Disregarded for Many Years

The property's orebodies lie under the area occupied by Black Lake. Partly because of this unfortunate location, plus recognition by engineers of the difficulties that would attend mining under the lake if orebodies did exist there, the immediate area covered by the lake was virtually disregarded until 1948. At that time, mineral rights were granted for claims defined as the area occupied by the lake at mean level. Later in the same year, exploratory work was commenced by the United Asbestos Corp. Ltd., a Canadian company, and in 1952 they brought the results of their work to Asarco for consideration. Shortly thereafter L.A.Q. Ltd. was formed by Asarco and an agreement made with United to continue exploration and mill test work, and to investigate the ways and means to uncover and mine the indicated orebodies.

In total, some 80,000 ft of diamond drilling and 14,500 ft of underground headings were completed in establishing the existence of the two main orebodies; and approximately 30,000 tons of ore was mined and milled in a 600-tpd pilot plant, to obtain data on actual fiber yield, fiber characteristics and qualities and to establish rate of milling, types of equipment required, flow sheet, and other information necessary for ore treatment and overall evaluation of the ore.



1. "A" and "C" orebodies
2. Becancour River diversion channel across north side of the lake
3. Interception ditch running from west side of reservior dam to Becancour River
4. Interception ditch (east side)
5. Relocation of 1.9 miles of highway back from shoreline
6. Widening and deepening of Becancour River
7. Disposal Areas A, B and C
8. Water return ditch to carry water from disposal area back to lake
9. Disposal area "C" dam
10. Trout Lake dam
11. Area affected by Trout Lake dam
12. Black Lake dam
13. Area affected by Black Lake dam
14. Dredge pipeline
15. Main office, mill and shop facilities
16. South Neck area

Fig. 2. Diagram of drainage project

Also, during this exploratory period, investigations and studies were made as to the best way to open up the orebodies and to estimate the probable cost of development and plant construction. In May 1954 decision was made to exercise the option agreement with United and to proceed with plans for exploitation.

Location of the two main orebodies designated as "A" and "C", with relation to hydraulic features constructed for mine development are shown by figure 2. Exploratory work to date has given lateral definition to these two orebodies, while a third, known as "B" orebody, lying between "A" and "C," has been only partially explored. Ore limits at depth have not been completely defined for any of the three ore zones. The ore tonnage calculated as amenable to open cut operations is 24,748,000 short tons, which, at the scheduled rate of production, is sufficient for 18 to 20 years of operation.

Complex Hydraulics Plan Required

The problem of completely changing a natural drainage system was the initial and most important one in planning successful development of the mine. Work during the first two years was confined almost exclusively to preparation of hydraulic structures for this purpose. It can be observed, by reference to the aerial photo, that Black Lake occupies a low lying basin, fed by the Becancour River, entering from the north and contributing runoff from an area of 57.5 sq mi; Nadeau Creek, entering from the northwest, with drainage from 10.5 sq mi; lesser streams entering South Neck accounting for another 7.5 sq mi; and the area around the lake itself totalling 5.5 sq mi. The Becancour River also provided an outlet for the lake.

In a district where average rainfall is 40 in. per year, made up of 30 in. rainfall and 100 in. snowfall, the diversion and control of these several feeders presented a problem of some magnitude. Provision had to be made for (1) diversion of the main streams around the lake; (2) control of their peak flows during storm periods; (3) acquisition of areas that would be

flooded during these high water periods and (4) in general, rearrangement of a set of drainage conditions, that nature had established in a most efficient manner, along the watershed for a distance of nearly nine miles. Figure 2 shows the main features of the overall hydraulic plan.

Dredge Chosen to Remove Soft Materials

Water level in Black Lake was originally at elevation 750 ft. The uppermost ore reached an elevation of approximately 670 ft with the top of bedrock varying in irregular outline down to roughly 480 ft. Extending over the lake bottom was a blanket 100 to 130 ft in depth of organic ooze, silt, sand and gravel, and immediately over bedrock a pockety layer of glacial till and boulders of varying thickness. Removal of all material, down to at least the glacial till, by mechanical means was obviously impossible—even had it been feasible to entirely drain the lake. The only practical solution seemed to be removal by a suction dredge, employing equipment and methods similar to those being used successfully at Steep Rock Mines, Ltd., in Western Ontario. After consultations and studies with engineers of Construction Aggregates Corp., the company doing the Steep Rock dredging, and others, it was decided that dredging would be feasible and, in fact, would be the only practical method of removing the soft materials at anything but a prohibitive cost, and within a reasonable period of time. Our experience to date proves that without the dredge as a material moving tool, the project could not have been completed.

As the dredge removed the soft material to established limits and elevations, the lake level was lowered in successive stages, and areas within pit limits were exposed which permitted mechanical stripping to commence on the upper benches. This general plan has been followed without major change and at July 1, 1958, date of start of production, the lake level was at 620 ft with waste stripping and ore mining proceeding on the 630 ft bench in both "A" and "C" pits.

Several articles (*Engineering & Mining Journal*, Jan. 1956; *Business Week*, June 8, 1957) have been written describing the dredge, its operation and method of handling solids. However, because of the importance of of this part of the preparatory program, further remarks seem justified.

The dredge and its auxiliary barges, pontoon line, shore pipeline, booster pump stations and so forth, were constructed by Construction Aggregates Corp. of Chicago, and commenced operating in July 1955. The 32-in. dredge pump, powered by a 6000-hp motor, handles materials varying from 17 to 20 percent solids at a rate of 35,000 to 45,000 gpm. Boulders up to 18-in. diam can be handled by the pump. The rotating cutter head at the end of the digging ladder is driven by an 800-hp motor, and in operation cuts a swath 250 ft wide by 40 ft in depth. Discharge lines are 32-in. O.D. by ¾-in. plate for the pontoon line and 32-in. O.D. by ½-in. plate for shoreline pipe. When pumping to the most distant disposal area, two booster pumps are required. These are of the same design as the dredge pump; one powered by a 6000-hp motor and the second by a 2500-hp motor.

Dredging operations have continued winter and summer since commencement, and as of July 1, 1958 a total of 26,646,748 cu yd of solids has been removed and stored in disposal areas. The best single month's operation was 1,454,135 cu yd of solids removed. Dredging is expected to continue until about mid-year 1959 when the total to be removed, as now scheduled, should reach approximately 31,000,000 cu yd.

Another useful method of applying the dredge's power for moving earth, designed by CAC's engineers, is the insertion of a 12-in. diam monitor nozzle in the pump discharge line to obtain the sluicing power of 45,000 gpm of water in a concentrated stream. Nozzle pressure is approximately 150 psi, and the stream shoots out for an effective distance of 400 to 500 ft. As much as 200,000 cu yd of material have been washed down in 24 hr from banks above the lake level by this monitor. By the use of the monitor it has been possible to lower the lake level more rapidly and thus expose sufficient area to allow mechanical stripping to proceed concurrently with dredging. The monitor has also been used very effectively for "blasting" out pockets of boulder clay immediately over bedrock that otherwise would have had to be cleaned by tortuously slow methods, including hand shoveling.

Pit Design Described

General plan of the mine and plant area is shown by figure 3. Certain limitations to open cut operations may

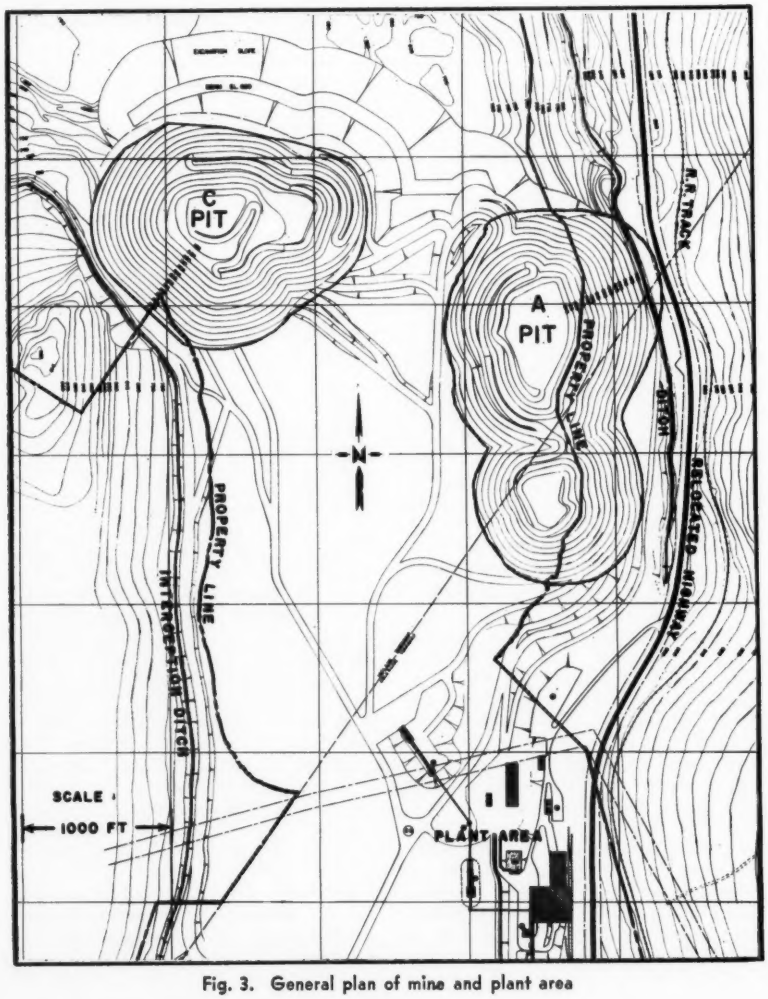


Fig. 3. General plan of mine and plant area

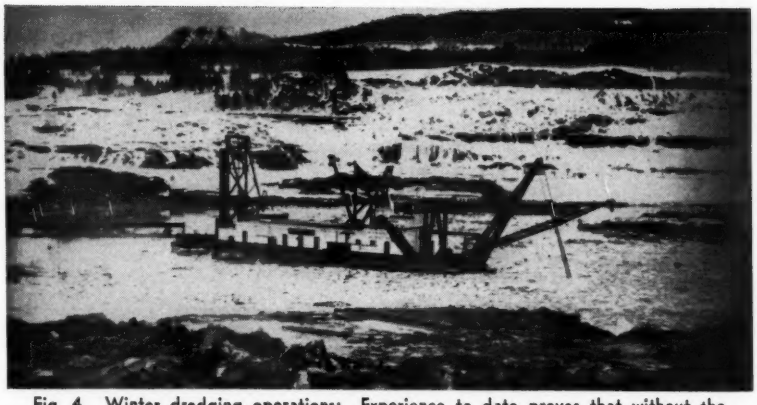


Fig. 4. Winter dredging operations: Experience to date proves that without the dredge as a material-moving tool the project could not have been completed

be noted on this plan, the most important ones being the Asbestos Corporation's property line, running through "A" pit, and the main highway, power lines and Quebec Central R.R. right-of-way paralleling the east side of "A" pit for some distance. Formerly the highway and power lines ran right through what is now the pit area, and it was necessary to obtain permission from provincial authorities (and pay the cost) to have 1.9 miles of the highway reconstructed in its present location. For open cut operations now planned, the railroad right-of-way is not affected. Ultimately, it may have to be rerouted and the highway may have to be shifted again.

In order to obtain the maximum economic value from asbestos fiber produced, ore production must come from both orebodies in the proportion of two tons "A" ore to one ton of "C" ore. Therefore, both pits have been prepared for initial production. After the limits of "B" orebody have been defined, it is likely that the pits may be joined and plans have made allowance for this possibility.

The ultimate pit limits for the "A" orebody will form an oval shaped opening, roughly 2450 ft long by 1400 across, with a depth from the uppermost bench (870) to the lowest (270) of 600 ft.

Final limits for the "C" orebody will form a circular shaped pit 1500 to 1800 ft in diam with the top bench at 830 and the bottom at 150—a total depth of 680 ft.

Pit design features include: vertical bench heights of 40 ft; widths of 100 ft for working benches and 70 ft for inactive benches that may be used only for haulage roads; overall slope in working areas of 2½ to one (horizontal to vertical), and reduction of bench widths after mining is completed to give a final bank slope of one to one.

Haulage roads are designed 50-ft wide for two-way traffic with maximum grade of six percent. Roads are ballasted with 1¼-in. rock and dressed with coarse and fine mill tailings. During winter months road surfaces often become icy and fine tailings are used to "sand" the roads. During wet weather the tailings become very greasy and have to be removed by grading. Layout of haulage roads is shown in figure 3. In "A" pit the lowest outside haulage road entrance will be on the 550 level and ramps will be made inside the pit to gain access to all lower levels. In "C" pit the lowest outside entrance will be on to the 470 bench.

All ore has to be elevated, as the dumping flat at the crushing plant is at 743 ft. Waste stripping also has to be elevated to the top of the waste dump at elevation 850.

Drainage and pumping storm water from the pits presents problems with some unknown factors. The northeast and northwest interception ditches are laid out to catch and carry off flows from above the mine and plant area. For areas below these ditches four collecting sumps are being constructed, each with a pumping station that will discharge into the interception ditches. Additional pumps of relatively large capacity will have to be provided to handle ground water and storm water, not caught by the sumps, inside the pits.

Equipment Performance and Output Increasing

Mechanical stripping commenced in late 1956 and up to July 1, 1958, a total of 5,854,584 cu yd of overburden and waste rock had been removed. Total waste stripping for open cut mining is calculated at 62,280,000 cu yd, a ration of 2.52 to one (waste to ore).

Working conditions in opening up benches were difficult, as might be expected with uneven terrain; soft material was left by the dredge overlying bedrock, and it would not support equipment; there was insufficient rock for road ballast; and other features, including difficult weather conditions, that are well known to Canadian and Northern U. S. mine operators, hampered operation. However, many of these difficulties are being overcome or removed, and equipment performance and output is improving.

Equipment now in use and performance figures for the year 1957 are as follows:

Drilling: Self propelled, caterpillar track mounted drills (4½-in. piston diam) have been used mainly to open up the top benches. Their ability to travel on the rough terrain without access roads has been important in the early stages of mine development. These machines drill three-in. diam holes, the average footage per shift being 197.6 ft.

Larger drills, five-in. piston diam, cat-track mounted, have also been used on the pioneering work and will be the main production drills. They drill four-in. holes at an average of 156.8 ft per shift.

One "down-the-hole drill," lately converted to electric drive for the compressor unit, is being used for drilling

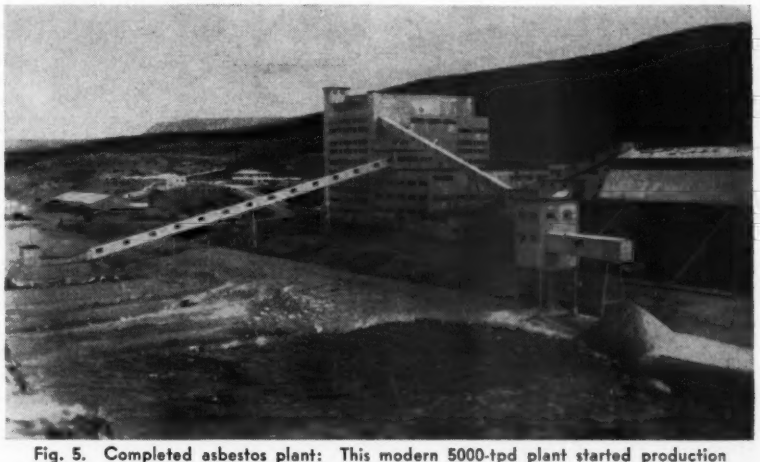


Fig. 5. Completed asbestos plant: This modern 5000-tpd plant started production July 1, 1958.

the granite formation that in places intrudes the serpentine. The granite is particularly hard and abrasive and the average performance drilling six-in. holes is 120 ft per shift. In serpentine formation this machine has exceeded 300 ft per shift.

Secondary drilling is done with a "travel-drill" and it has been found to be a safe and a very useful machine. Semi-portable (skid mounted) electrical and portable diesel compressors supply air for drilling. Pipe lines are kept to a minimum.

Blasting: No special features or practices: For the serpentine formation 40 percent special gelatine is used, and in granite both 40 and 60 percent gelatine are used. Ammonium nitrate with pentalite primers has been used with fair success but, because of the many wet holes, its use has been limited.

Average tons broken (including secondary blasting) per lb of powder is 3.15 in serpentine formation and 2.63 in granite.

Loading: Present loading equipment consists of three 4 cu yd electric shovels and one 2½ cu yd diesel unit. Several smaller diesel units are used for miscellaneous chores such as drainage ditches, sumps, etc., and for cleaning out pockets of glacial clay immediately over the ore. In general, shovel working conditions have not been good because of low irregular banks, soft bottom conditions—in many places requiring use of timber mats and rock ballast—and the average loading rates per shovel shift of 3000 tons handling rock and 3300 tons for overburden are comparatively low.

Hauling: A fleet of 20 to 22-ton rear dump trucks handle ore and waste hauling. Truck bodies are exhaust heated for winter operation, and on the whole even the soft material clears well when dumped. Anti-freezing compounds are not used, chiefly because of their possible contaminating effect on the fiber.

One-way haulage distances average 3000 ft for ore and 6300 ft for waste. Performance per truck shift during 1957 was 413 tons, but this year, due chiefly to improved road surfaces and better pit bottom conditions, the haulage figure is showing a substantial improvement.

Power: Electric power for the Black Lake-Thetford Mines area is supplied by Shawinigan Water and Power Co. A 66-kv line, approximately four mi in length, was constructed to the property to supply power for dredging, mining and milling.

Permanent pit lines now partially constructed are 4160 volts with grounded neutral. They will circle the pit areas. Branch feeder lines, mounted on portable steel poles, lead to skid mounted switch stations from which trailing cables are run to shovels, compressors and pumps. Shovels operate on 4160 volts and compressors and pumps on 550 volts.

Pit lighting is supplied by 1000-watt mercury arc lamps with small rectifiers supplying 550-volt dc power.

Construction of the milling plant (figure 5) including its components of crushing plant, wet rock storage, dry rock storage, dryer building and fiber storage building was started in May 1956 by F. H. McGraw Co. of Canada Ltd. and was completed by the end of May 1958. It started operating, initially on one shift basis, July 1, 1958. A description of the mill, its equipment, quality control features, and so forth would no doubt be of much interest, particularly to mining men who have not had experience in asbestos production. It is hoped that at some later date a review of this most important part of the operation can be presented by one of our milling technicians.

Poor roof . . . heavy rock partings . . . steep grades . . . mountain bumps—these are some of the severe conditions affecting maintenance of ripper type continuous mining machines at a western coal operation. The report outlines major areas of breakdowns and discusses company maintenance practices distilled from nine years of experience with these a-c machines

MAINTENANCE of A-C Continuous Mining Machines

By LAMAR T. LINDSAY
Shop Foreman
Sunnyside Coal Mines
Kaiser Steel Corp.

RIPPER type continuous mining machines have been in use at the Sunnyside Mines of Kaiser Steel Corp. since 1949. At present ten units are utilized. They are operated on a two-shift basis and average 250 tons per shift. Nine units are scheduled for operation and one for a complete overhaul in the outside shop.

The continuous mining machines, as well as conventional cutting and loading equipment, are exposed to mining conditions conducive to high maintenance:

1. **An extremely poor roof which gives rise to many roof failures despite extraordinary roof control measures.**
2. **Heavy rock splits and cap rock which come with the coal as it is cut down and loaded.**
3. **Steep grades—up to 20 percent.**
4. **Mountain bumps which inflict severe shocks to equipment. It is not unusual for a continuous mining machine weighing 24 tons to be lifted several feet off the floor by a bump. In addition, roof falls on equipment occasionally follow a bump.**

This article will deal with major areas of breakdowns derived from nine years' experience in the maintenance of ripper type machines.

Lubrication

Proper lubrication is of the utmost importance in preventing breakdowns. All moving parts and gear cases should be kept well lubricated with the proper type of lubricant. The lubricants Sunnyside uses are specified by the manufacturers, and management has found that deviation from recommended lubricants will usually cause delays.

A set greasing schedule for checking and flushing gear cases is maintained. This is done on the third, or non-productive, shift.

Head End

Two types of heads have been used at Sunnyside; the 4-ft 6-in. bar cutting to a height 7 ft 6 in., and the 7-ft bar cutting to a height of 10 ft. The long bar is preferred, and all machines with one exception have been equipped with the long bar.

The idler head assembly or cutting head consists of a splined rotating shaft supported at two points by Timken roller bearings. The shaft carries the five sprockets and a bit carrying ring "pineapple" on either side.

Bearing failure in the cutting head has caused a great deal of the firm's down time. This is in part due to the necessity of having to move the continuous mining machine back from the face to lubricate these bearings. If the bearings were connected to the automatic greaser, a lot of expensive down time could be eliminated. Contributing to bearing failure is the severe shock loads imparted on the head in cutting heavy rock splits, and by heavy pieces of cap rock dropping on the cutter head as the cutter bar removes the coal.

Ripper Chains

Life of the ripper chains averages about one year, or 90,000 to 100,000 tons of coal. Rebushed and pinned chains average approximately 75,000 tons of coal before replacement is necessary.

Bar Gear Cases

These are driven by two 65-hp motors and protected by a clutch on the drive shaft. The clutches are set to slip at 135 to 145 amps at 440 volts a-c. Each motor should be run independently of the other for settings. Since the Sunnyside operation has machines with both the worm and bevel gear type cases, management has found the bevel gear type to be a big improvement. They are much simpler to adjust, and the down time and maintenance problems are greatly reduced.

Clean Up Devices

Scroll and paddle type of clean up devices have been used. Neither have been successful due to rib sloughing and the rock handled, and more recent models have been purchased without the clean up device. As an aid in cleaning up, a shoe is inserted on the underside of the head, flattening out the angle of chain traverse. The 11BU pick up loader working behind each continuous mining machine is Sunnyside's chief reliance for good clean up. It is understood that the recent gathering arm type of clean up device does work satisfactorily, and the firm's new 6CM models will be so equipped.

Power Take-Off Assembly

The front conveyor is driven by the cutting motors through the power take-off assembly. This is protected by a slip clutch located on the output shaft of the power take-off assembly.

LaMar T. Lindsay has been associated with Kaiser Steel Corp. since 1950, serving as shop foreman at the firm's Sunnyside Coal Mines in Utah. Prior to joining Kaiser, he served as mechanic, preparation plant superintendent and master mechanic for Utah Fuel Co.

The clutch is adjusted to slip at 175 to 200 ft lb of torque at the coupling and it is important that a torque wrench be used for this adjustment. This gear case has only a one to one gear ratio; therefore, lubrication is very important due to the high speed of the unit.

Traction Drive

Caterpillar pads have to be cross-lugged to help hold the continuous mining machines into the face and for tramming in the steeply pitching areas. Due to the adverse mining conditions it has been found necessary to tram the machines from face to face in the same manner as with a conventional loading unit. The long delays incurred in providing roof support have made this necessary. The normal tramming speed of 39 fpm was too slow and recently two-speed tram motors were installed on one machine. They are rated at 7½ hp in low tram, and 15 hp in high tram. The speed of tramming has been increased to 65 fpm with very beneficial results. Greater clearance was also provided by raising the machine 2 in. higher from the floor level by adding a 2-in. piece under the caterpillar frames. On the Sunnyside's new 6CM units tramming speeds close to 100 fpm will be attained.

Turntable and Sumping Frame

The bearing and hold down ring on the turn table bearing has been a source of considerable trouble. Due to the hardness of the cutting, the pressure transmitted to the backside of the hold down ring is very heavy. This has caused many of the studs in the hold down ring to shear off causing bearing breakage. In the past year the firm has been drilling and tapping extra holes in between the present cap screws so as to add six more cap screws to the rear of the hold down ring. Experience to date has proven this to be an important improvement. An extra hole in the bottom of the sump frame has been added so that the mechanic can flush this bearing out once a week and refill with new grease. This has resulted in the turn table keeping free, reducing the maintenance on the swing jacks.

Sump frames have developed several weak points. Considerable reinforcing to the frame is done when a machine is brought to the shop for its scheduled overhaul. The wear shoes and guides for the sumping frame are checked at regular intervals so that the wear will not cause misalignment between drive motors and ripper bar cases.

Conveyor Chains

Two types of conveyor chains are in use; the riveted welded section, and the taper pin flight sections. Conveyors have been speeded up 25 percent to help keep the coal from piling up and spilling over the center hopper section and sides. Elimination of the hopper and a wider conveyor will add up to an important improvement in new models. A changeover to bevel gear cases has been made on all conveyor drives.

Hydraulic System

Hydraulic Pump

The pump operates at constant volume and is made up of two sets of matched sets of spur gears. There is a common intake for both sets of gears and a discharge for each set. This pump is a precision product and should not be disassembled unless absolutely necessary. If this pump should cease to function properly, (providing adequate tests have been made to determine that psig is lower than minimum requirements) there is a very definite method of putting the machine back in operation after a new pump has been installed. Failure to follow these important details will result in a pump that will not deliver satisfactory service.

1. **Pump should be installed according to good mechanical practices.**
2. **Oil in hydraulic tank should be drained and flushed. (This should be stressed very strongly because of the possibility of metallic or foreign material held in suspension in the oil.)**
3. **If the hot hydraulic oil can't be drained and the machine has to be put back in operation, the following procedure should be noted:**
   a. **Prime pump before turning pump motor on.**
   b. **Inch pump motor for five second intervals or until suction begins. (Check for correct rotation.)**
   c. **Run pump intermittently starting and stopping until pump body has reached the same temperature as the oil. After the pump has warmed sufficiently to permit running, it should be operated for a period of 20 minutes at 0 psig. Rapid or unequal expansion of the close fitting internal parts is eliminated by this method.**

A-C continuous mining machines at Sunnyside were found to have about 50 percent less maintenance due to electrical and motor failure

Overhaul time averages around 200 manshifts and costs in the neighborhood of $17,000 to $25,000

Tank and Filter

The hydraulic oil tank provides a reservoir of oil for the operation of the various circuits. It acts as a surge tank when the cylinders are collapsed and allows the oil to be cooled through heat dissipation.

One of the most important factors in achieving long satisfactory service from the numerous hydraulic devices on this machine is cleanliness. This one, seemingly unimportant, detail has caused more precision hydraulic units to fail than any other known factor. The tank and filter chamber should be drained and flushed at periodic intervals for the removal of contamination. Two edge filtration type cleaning filters for removing particles of dirt from the hydraulic oil have been provided for on this machine. If the filter handle is not turned frequently, flow to the pump will be retarded and pump failure will eventually result. A manometer reading at this point should read not less than 12 in., and not more than 15 in. of mercury.

Control Valves

Control valves operate on the principle known as the open center system. This control unit is a precision assembly and should only be dismantled by competent persons who have had the proper training to handle precision work of this type. In a valve of this design, very close tolerances are maintained, and the spools are individually lapped into the respective housings. If the spools or the valve body become worn to the extent that excessive slip is encountered, a complete unit should be installed. Spools and valve bodies are not interchangeable. Badly worn valves will allow excessive sluggishness or become non-existent.

Relief Valves

Reciprocating motors that convert hydraulic energy into mechanical linear movements are used almost exclusively on this machine. The only other electro-mechanical movement is the ripper chains and the tramming arrangement. The rear conveyor is elevated by a telescoping single action cylinder. Conveyor articulation is accomplished by two double action cylinders hooked in a reverse parallel arrangement. The sump is actuated through two horizontal double acting cylinders piped in parallel. Three operations take place when the machine is sumped forward. The brakes lock, the scroll moves out, and then the ripper bar moves into the face. The ripper bar assembly is moved through the complete cutting cycle by two double acting cylinders that are also connected in parallel. The scroll elevating mechanism consists of two single acting cylinders that are also connected in parallel. The purpose of this is to elevate the unit from the bottom, eliminating the possibility of damage when the machine is tramming.

Hydraulic Converters

Two independent relief valves have been provided in the main valve assembly to assure protection for the various operational devices in the event of individual relief valve failure. The setting of these valves should not exceed 1500 psig. Individual relief valves are established for each circuit in a separate relief valve bank. These units act to protect the system by preventing excessive pressure buildup. It seems to be common practice for some misinformed mechanics to set these relief valves to operate at a higher psig to compensate for a failing pump. If a pressure drop is evident, proper tests should be conducted to determine cause and location. Excessive relief valve setting (above manufacturers extreme limit) only tends to cause a vicious cycle. Higher temperatures caused by increased pressure settings tends to cause the oil to be less viscous and creates excessive slip in the pump gears. This cycle repeats itself and eventually would cause complete hydraulic failure in all operational circuits.

Hydraulic Hoses and Fittings

Due to manufacturing changes, Sunnyside Mines had continuous mining machines with several different types of hydraulic hose fittings. This caused a lot of delays and expenses until management was able to standardize on one type of fitting, and a standard 3000 lb pressure hydraulic hose. The standardization has offset the initial cost by eliminating excessive inventory and enabling quicker repairs on breakdowns.

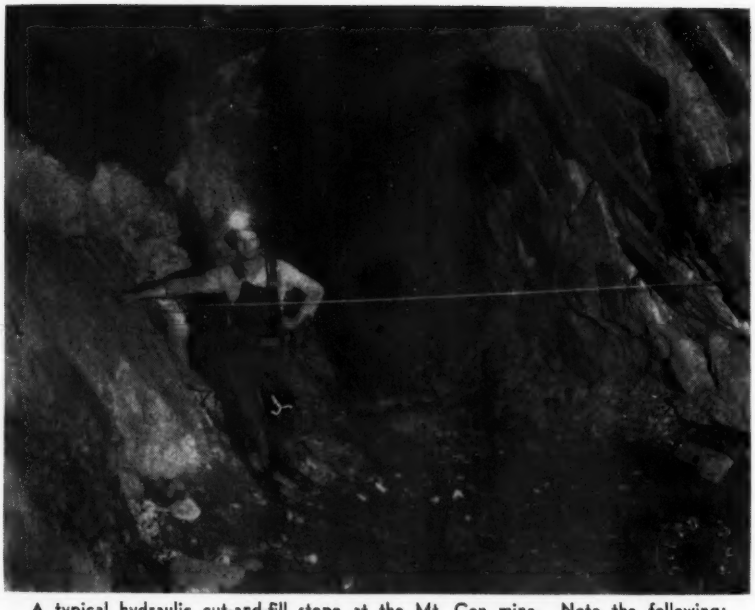
Electrical System

Maintenance on the electrical system calls for inspection of contractors, connections, and regular motor inspection. To date there have been only two tramming motor failures on all

(Continued on page 71)

Careful study and experimentation have paid off for Anaconda. Mining techniques have been developed which avoid extensive timbering and allow the efficient use of hydraulic fill, rock bolts, concrete linings and steel sets. The results are lower costs, higher production per man, and safer operations

MINE SUPPORT at BUTTE



A typical hydraulic cut-and-fill stope at the Mt. Con mine. Note the following: (1) temporary support of hanging wall and back by rock bolts with wooden head boards; (2) firm, level floor provided by fill; (3) back mined normal to walls and level along the strike of the vein, (4) lack of open space which eliminates opportunity for falling man accidents

By JERRY M. WHITING

MINE support at Butte has changed considerably in recent years. It's relatively hard today to find active workings where square-set stoping with rock fill, or extensive drift timbering—two operations long associated with the deep mines of that district—are in progress. Ground characteristics have not changed, but The Anaconda Co. has been alert to try new types of supports and develop new mining techniques.

Some changes were brought about because a mining method new to the district—block caving—was started at the Kelley mine. With this method came (1) the use of concrete drift linings and (2) limited use of both rigid and yieldable steel sets. In other mines, however, where highly selective mining is necessary, major improvements have been made in mine support by (1) decreased use of timber and rock fill, (2) extensive use of rock bolts and (3) inventive application of hydraulic backfilling. In addition, efficient timber handling routines have been established. To Anaconda, these changes mean lower costs, higher production and safer operations.

This article will outline some of the high points of mine support at Butte by describing the use of concrete lining and steel sets at the Kelley mine and the use of hydraulic fill, rock bolts and limited amounts of timber at the Mountain Con mine.

CONCRETE LINING AND STEEL SETS

The use of concrete at the Kelley mine is succinctly described by Martin Hannifan, assistant mine superintendent, in "Concrete for Ground Support in the Kelley Mine," *Quarterly of the Colorado School of Mines*, July, 1956. The author will therefore limit his discussion of this subject to observations made on a recent trip to Butte.

At the Kelley mine, openings on the haulage level are run bare wherever possible. Timber sets are used in localized portions of bad ground and for lining haulage drifts in areas adjacent to the block. Short sections of concrete lining are poured where support greater than that afforded by timber is needed.

At the present time, pony sets are installed above the haulage level. Timbered slusher stations are placed at regular intervals along the pony drift on the side away from the block. Concrete-lined slusher drifts extend under the block at right angles from the pony drift. In the future, pony

Rock bolts (left) have replaced timber sets (right) in many Butte drifts. It is estimated that the reduction in drift cross section permitted by the use of rock bolts has saved handling over 10,000 tons of waste at the Mt. Con

drifts will be replaced by "fringe drifts" driven above the main haulage drift on the side away from the block, and the slusher stations will be concreted. These modifications will be made to avoid the heavy ground immediately adjacent to the block and thereby reduce repair costs.

Grizzly levels have been eliminated recently for two reasons: A block caving system without a grizzly level requires less development work and the elimination of grizzlies does away with a major safety hazard. In the past, several accidents occurred when men fell through the grizzlies.

Concrete Linings Enable Profitable Operation

Fast materials handling is one of most important factors in selection of the block-caving mining method. The low-grade ore at the Kelley mine must be moved with a minimum of delay and at the lowest possible cost. Two factors are vital for profitable operation of the mine—slushers and concrete lining for slusher drifts.

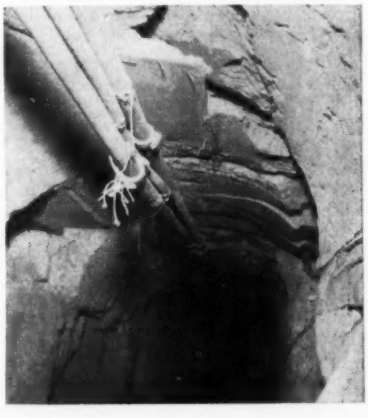
Concrete is prepared at the surface in a standard type pre-mix plant operated by the company. Here the concrete is mixed using 5½ to six bags of cement (type two) per cu yd, and is loaded into pre-mix trucks for transportation to the pipe that carries the material underground. Most of the concrete is handled through a pipe down the Kelley shaft, but it can be poured down a lined drill hole if desired. About a six-in. hole is used. Underground, the pipe discharges into specially designed cars which have a sloping bottom to make removal of the concrete easy. The cars transport the concrete to a sump with an inclined bottom. A slusher bucket runs up the inclined bottom, scraping the concrete from the sump and dumping it into either a "pumpcrete" machine or a pneumatic placer. From the "pumpcrete" machine or pneumatic placer, the material is pumped through quick connecting pipes to the area where it is placed. Specially designed forms are used which facilitate placement of the concrete. Concrete is poured to a minimum thickness of two ft in the back and 18 in. in the wall of the standard eight by six-ft semi-circular slusher drift.

The cross-section of the drift is kept at a minimum by using rock bolts and wire mesh, or steel sets made of old mine rails, for preliminary support prior to placement of concrete.

The total cost of concrete lining: $116.14 per linear ft. This cost is the total cost including development of an eight by six-ft slusher drift. The average cumulative concrete cost for 12,000 linear ft of slusher drift is $72.12 per ft.

Openings in the Kelley go through virgin rock, old gob from previous mining operations in square-set stopes, and old fire country that was slime filled. These different types of materials provide varying degrees of backing on the periphery of the concrete lining which results in an unequal distribution of stress around the lining. The resultant distortion of the lining causes it to crack and break. It is characteristic for the lining to crack at the center of the semi-circular arch and for one half of the arch to override the other half. Extensive cracking and separation of the concrete gives the appearance of impending failure, but the concrete lining remains an effective support through this stage. Failure is never sudden.

Extensive cracking and separation of concrete lining give the appearance of impending failure, but the lining remains an effective support through this stage. Failure is never sudden



Where particular difficulty is encountered, such as in portions immediately adjacent to the finger raises, steel reinforcing is used. Most of the lining, however, has no reinforcing.

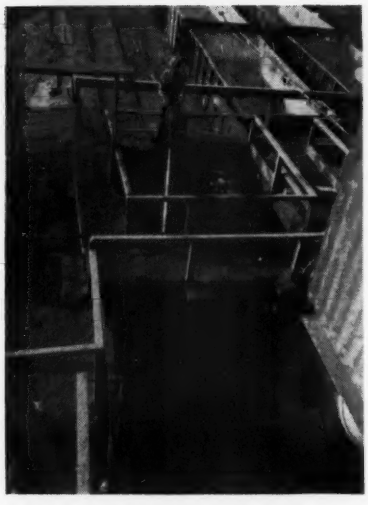
Research studies are underway to determine the actual strength of the concrete after it has been transported, poured and has hardened. Reports of compressive strengths are not yet available, but it is known that several factors reduce the strength below that theoretically possible under optimum conditions, and thus shorten the effective life of the lining.

For example, a fluid mix is necessary to allow passage of the concrete through the long series of pipelines without plugging, and to keep the time between mixing and placing at an allowable limit. This decreases the concrete's strength in relation to that possible with a lower water-to-cement ratio. (An additive was tried which increased fluidity without increasing water. It allowed cutting one-half to one bag of cement per cu yd of concrete while providing the same design strength, but the saving was not substantial enough to warrant its continuous use.) Segregation causes serious localized defects in the lining. In general, it becomes more of a problem when a drier mix is used, or with an increase in the distance the concrete must be transported in pipes.

It is most important to note, however, that probably the largest loss of strength results because the newly poured, "green" concrete must take a load almost immediately after placement.

Many attempts have been made to extend the life of the concrete lining including: (1) changing the shape of the cross-section and (2) installing steel sets to reinforce the concrete when it begins to fail.

Operators believe an elliptical cross-section is stronger than a semi-circular arch with straight legs (or walls). The elliptical shape, though, interferes with scraper operations. The semi-circular top of the slusher drifts in use at present helps prevent plugging by allowing the scraper to ride higher when the drift is flooded with ore.



Butte has no mill. Tailings are brought from Anaconda, 26 miles away. Tailings are either washed (above) or shaken (below) from the railroad cars. The first method has the disadvantage of offering little control of pulp density

Steel Sets Limited to Special Uses

Rigid steel sets, made of 10-in. H-beams or old mine rail, are installed to reinforce concrete lining where particularly heavy ground is expected or failure appears imminent. Any blocking between the H-beam sets and the concrete is loosened during blasting. Sets are therefore held in position with six by six-in. wooden girts. A modification for reinforcing the lining with a rail set is on the drawing boards. In the future, lining will be cast with a six-in. notch on each side at specified intervals to receive the end of a steel rail arch. The steel arch will be installed as soon as the center of the lining starts to crack.

Yieldable steel supports have been tried at the Kelley with little success. Their failure seemed due to unequal stress distribution which caused the sets to buckle or slip out of lateral alignment rather than yield as intended. Operators at the Kelley are far from sold on yieldable steel arches as they believe the ground conditions encountered in slusher drifts, as described earlier, do not allow the sets to be loaded properly—that is, uniformly. Furthermore, recovery is impractical in most instances. Where the sets can be recovered many of the operators question whether they were ever really needed.

On the first installation of yieldable steel supports, initial cost was $94.20 per linear ft (this cost also included driving the development heading) and repair costs were $91.00, making a total of $185.20 per ft. On the second installation, extreme support requirements were encountered and it was necessary to pour concrete behind the sets to stabilize the ground and keep them from being crushed before the block was completely drawn. The total cost was $170.00 per ft. Compare these two costs with $116.14 per ft for concrete lining.

Although yieldable arches are not regarded as applicable to Kelly ground, operators point out that in the first example of support in extremely heavy ground cited above, the arches allowed the draw to be completed before major repairs were required.

The following excellent results have been attained since the switch from timber to concrete at the Kelley mine: (1) block repair costs have dropped 76.4 percent with an increase in efficiency in this phase amounting to 52 tons per man shift; (2) ore drilling costs have dropped 33.6 percent with a corresponding increase in efficiency of 66 percent in tons per man shift; (3) ore loading and tramming costs have dropped 17.2 percent with a corresponding increase in efficiency of 30 percent in tons per man shift.

HYDRAULIC FILL AND ROCK BOLTS

Hydraulic fill, locally referred to as "slime" fill, was first used in Butte in 1917 to extinguish a fire in the Leonard and Tramway mines. Subsequently, its use has expanded not only in mine fire control and prevention, but in ventilation control, preparation of stoped-out areas for block caving, and most important—mine support. At the end of 1957, over 8,000,000 tons had been placed underground.

An experimental hydraulic fill program started in 1953 at the Mt. Con and Anselmo mines had the following objectives: (A) provide permanent ground support, (B) prevent initial failure or ground movement by decreasing the time ground was left unsupported, (C) improve ventilation, (D) decrease fire hazard, (E) eliminate or decrease use of timber, and (F) allow use of more efficient mining methods. The program is no longer experimental. All of these objectives have been attained to varying degrees. The most important net results can be stated simply: (1) greater safety and (2) lower mining cost per ton of ore.

The success of this program was partly due to increased industry experience in handling pulps, and to development of suitable equipment for preparing and transporting hydraulic fill. It was also due to the progressive outlook of the company. Anaconda personnel were inventive in applying the new support method to their operations and were determined to give it a fair trial.

The use of hydraulic fill at Butte can best be outlined by describing operations at the Mountain Con Mine. At this mine, hydraulic fill can be used to maximum advantage.

John Suttie, mine superintendent, has described hydraulic filling at the Mt. Con in considerable detail in a paper presented at Montana School of Mines Symposium on Hydraulic Fill entitled, "Details on the Hydraulic Fill Method Used at the Mt. Con Mine, Butte, Mont." The Author has relied heavily on Mr. Suttie's paper for the following information.

The Mt. Con, in operation since 1878, is almost 5000 ft deep. Copper ore is mined from five veins. The end of the veins extend 4000 to 5000 ft from the shaft and may be up to 10,000 ft apart. Faulting and other movement has fractured the "granite" country rock several feet on either side of the veins. The altered country rock immediately adjacent to the veins is subject to air slacking, or continued spalling, when exposed to air.

Except in a few localized "trouble spots," openings driven in the country rock, which do not enter the weakened zone adjacent to the vein, can be supported indefinitely by rock bolts. The walls of the vein, however can be supported only temporarily by rock bolts. Timber, rock fill or hydraulic fill must be quickly placed in stopes to prevent serious ground movement or failure.

Yieldable steel sets have been tried at the Kelley mine. Difficulties were encountered because the type of ground traversed by the Kelley's slusher drifts would not load the arch uniformly

Care Taken Developing Workings Prior to Filling

It is worthwhile at this point to describe briefly some of the development and mining procedures which are carried out prior to filling.

Laterals are driven at a distance of 40 to 50 ft and parallel to the expected course of the veins. Sometimes veins are drifted out for exploratory purposes and lateraled after they have clearly defined. Crosscuts are driven on 160 ft centers and extend 80 ft through the vein to give ample tail room for loading. Stopes are silled out on the first floor by driving an 80-ft intermediate drift each direction from the raise. The average stope has a width of from eight to 12 ft, and a dip of 50 to 60 degrees.

In veins dipping *less* than 80 degrees, the back of a stope is carried normal to the walls. This is important, because a horizontal back allows a dangerous rock "wedge" to form which continues to slough from the intersection of the back and foot wall along a line normal to the hanging wall. When the back is drilled on a line normal to the walls, however, it stands very well. In stopes over 12 to 15 ft wide, a back at right angles to the walls is impractical, because level-run tailings do not adequately support the hanging wall. In these stopes a compromise between a horizontal and a normal back is made, and rock bolts are placed on closer intervals to make sure the back is tied to competent ground.

In veins dipping *more* than 80 degrees, the back is arched to the middle of the vein, and special care is taken to tie the ore close to the wall to competent ground by the use of rock bolts.

There is a strong tendency for miners to carry the back at an inclined angle from the raise as the stope progresses. Considerable care is required to keep the back level along the strike of the vein or, in other words, perpendicular to the raise. A back that inclines upward from the raise creates the following problems: (1) a triangle of unsupported ground develops near the raise; (2) bar-down operations are hampered because the back is too high after clean-up; (3) fill runs in level and, therefore, in order to maintain adequate clearance under the brow, an increasing amount of hanging wall must be left unsupported toward the end of the stope. Slacking may occur before the second cut can be mined and another layer of fill placed, thus producing a dangerous ground condition.

Source of Fill Creates Unique Preparation Problems

At this point in discussion, it is necessary to leave the underground work for a few paragraphs and call attention to the surface preparation for hydraulic backfilling.

Butte is unique compared to most hydraulic fill operations in that there is no mill to supply classified tailings to the mines. This is a distinct disadvantage in at least three ways: (1) unloading, (2) mixing, and (3) some of the physical properties of the fill.

Hydraulic fill starts its journey to the mine workings from an old tailings settling pond near Anaconda, Mont. There it is loaded by dragline into bottom-dump railroad ore cars for transportation into Butte, 26 miles away. When the tailings were originally deposited in the settling pond, they were classified to some extent by natural hydraulic forces. Extensive sampling has outlined that portion of the deposit which contains material of the proper size. (Only up to 3½ percent minus 20 micron particles can be tolerated in the tailings.) No other method of classification is used.

The type of hydraulic fill plant used in Butte depends on how the tailings are removed from the ore cars. At the Mt. Con, Anselmo, Badger, and Leonard plants, fill is *washed* out of the cars with streams of high-pressure water. This method has a serious draw-back because it allows only slight control of the resultant pulp density. Consequently, the pulp varies between 50 to 60 percent solids, which is below the optimum percentage. The Lexington plant (see *Mining Engineering*, April 1958) has provisions to *shake* the fill out of the cars and, therefore, can control the amount of water added to the fill. Hence, fill is sent underground at a higher pulp density—between 65 and 70 percent solids.

The water content of the pulp is an important factor in filling operations. Lower water content has several major advantages: (1) operating at the rate of 100 tph of dry sand, an increase in pulp density from 50 to 70 percent solids results in a decrease in drainwater from 21,300 to 7600 gal per hr (consequently, two-thirds less pumping); (2) fewer leaks in the stopes; (3) less segregation; (4) less slimes carried through the filter bulkhead (reducing clean up); (5) lower pipe line velocity (decreasing wear), and (6) faster draining and better consolidation.

In addition to the unloading and mixing problem, tailing used in Butte contains a small amount of tramp iron and oversize rock. This creates screening, pumping and maintenance problems not customary in hydraulic fill operations elsewhere.

Placement Follows Definite Steps to Avoid Trouble

In the placement of hydraulic fill, the problem is to maintain fluid characteristics while transporting the sand, and then to quickly stabilize the sand when it is in place to avoid the hazards of extreme hydraulic heads.

As mentioned previously it is important to keep the back of the stope level along the strike of the vein. To assure this is done, stoping operations at the Mt. Con are started by driving a level intermediate drift. Either a cut is taken over the drift before filling, or else the stope is cleaned and filled immediately, depending on ground conditions. Old guides or stulls are laid on the floor along the strike of the vein and crossed with scrap wood. This prevents the tailings from running when the sill pillar is mined out from below.

When a stope is cleaned out, filter walls are built of lagging placed horizontally across the stope and covered with a single thickness of 7½-oz burlap. Three-inch spaces are left between the lagging to allow the passage of drainwater. Holes at the contact of the filter walls and the stope walls are chinked with rolls of burlap, and if the walls are cracked, burlap is draped over that section because hydraulic fill will penetrate even small cracks.

A good "hitch" or secure bottom is very important in preventing filter wall breakouts. For this reason, a two-ft deep trench is dug to uncover the top portion of the burlap on the previous wall. New burlap is run over this old burlap, across the bottom of the trench, and up the other side. The trench is then filled with tailings and tamped solid. Lagging of the lower wall is checked to make sure there are no pieces that will break under the hydraulic pressure of the newly poured fill.

When fill is to be placed against ore at the end of the stope, a gob fence is made to hold the tailings and prevent dilution when the ore is mined away from the other side. A slight

Packaged timber is distributed to all mines from a central yard. Arrangements at shafts and stations avoid piece-at-a-time handling

support is all that is required to make sure the fill stays in place. Stulls wedged from wall to wall and lagged vertically with three to four-in. spaces between the lagging are sufficient. In wide stopes, stulls are stood against the breast and lagged horizontally.

Veins too wide to be held temporarily by rock bolts are mined in two parts. The half nearest the hanging wall is mined first in normal fashion. A gob fence is then placed over the ore that is next to the foot wall to hold the tailings when the next cut is mined. This process is continued until the vein narrows enough to be mined by one cut. Then the half next to the foot wall is mined.

The fill is pumped horizontally from the plant to the shaft, and from there to the sill lines, in four-in. rubber lined pipe. A two-in. breather pipe on the surface is left open when running. If closed, the flow of tailings is reduced immediately, accompanied by considerable vibration and hammering in the sill lines. (Rubber lined pipe is used on all levels where concentrated stoping is in operation. In less active areas three or four-in. victaulic pipe is used, preferably extra heavy. Pipes are rotated to increase their life, as wear concentrates on the bottom and at portions where there is a change of direction.)

Hydraulic fill tends to cone or pyramid at the place where it is discharged. Therefore, the fill line is hung from the back and extended to within 20 ft of the end of the stope. When the fill is discharged at the end of the stope, a slight downgrade slope is formed which forces the water to drain toward the filter wall as soon as filling starts. If the fill line extends only a short distance into the stope, two problems may develop: (1) a pool of water builds up in the back end of the stope which may surge against the filter wall and cause a break-out of fill, and (2) a low section develops in the back-end of the stope, and ore is either left in this section or tailings are slushed out ahead bringing this ore to the chute.

The decanted water runs down the chutes to the sill. If left uncontrolled, any solids that are carried along settle out in ditches and in pump stations, and cause excessive pump wear. Uncontrolled drainwater sometimes overflows ditches and causes wear on carbearings, wheels, etc. Also, cleaning ditches and sills is costly. To eliminate these problems, two filter walls are built underneath the chute before the stope is filled. When drainwater runs down the chute to the sill it is decanted through the walls, picked up by a pump, and piped into an abandoned heading. There the fines settle out and the clear water can run out along the ditches at a controlled rate.

A hydraulic fill system must have good voice communications. At Butte, the underground filling crew is always in contact with the surface immediately preceding and during filling operations. A Webster master station is installed at each plant, and University dual purpose (two-way communication) speaker horns are used underground.

Use of Rock Bolts Vital Part of New Methods

The success of hydraulic cut-and-fill stoping at the Mt. Con depends, to a large extent, on the use of rock bolts to eliminate timber. In order to fully realize the advantages offered by the use of rock bolts, provide a safe mining floor, and help prevent dilution of the ore, the following mining practices are required: (1) thorough rock bolting and stulling of the brow; (2) careful drilling to avoid having holes enter the hanging wall; (3) back holes drilled horizontally in the direction of the strike and, at the same time, placed along a line on the face that is normal to the walls; (4) use of low strength powder in minimum quantities; (5) rock bolting all open ground on about five-ft centers after each blast; (6) making sure all rock bolts are anchored to self-supporting ground; (7) keeping bearing plates and head boards tight to prevent rock sloughing away from them, and (8) placing the maximum allowable amount of fill as soon as possible after the cut is made.

Both slot-and-wedge and expansion type bolts have been tried. Slot-and-wedge bolts are preferred, because they can be installed in a smaller hole which can be drilled at a faster rate. Furthermore, the size of the hole is not as critical, and therefore a wider range of bit sizes can be used. It is also easier to get a better job of installation with the slot-and-wedge bolts.

Two-ft long, three by 12-in. wooden head boards are used to hold a maximum amount of ground with each bolt. A 3½-in. diam, ¼-in. washer is used between the nut and the head board. This is sufficient for average ground weight in stoping, because fill is soon placed to reduce open ground to a minimum. Five by five-in. plates are used as bearing plates in areas where the ground is unusually heavy.

In extremely heavy or broken ground, or where ground tends to crumble away from head boards, cyclone fencing or steel landing mats can be used to support large areas. Grouted rock bolts can be used effectively in fault gouge. These techniques, however, are seldom used in Butte stopes.

Rock bolts placed in the hanging and foot-walls of the raises make it possible to eliminate the use of gob lagging and help prevent initial ground movement. Thus, they keep weight off the timbers and lengthen the life of the raise.

Rock bolts are also used for many auxiliary purposes. For example, one-in. salvaged bolts are formed into slusher pins. Four by six or eight-in. wooden planks, hung a few inches from the back by rock bolts, are used to carry water, air and electric lines and provide an over-head mounting for ventilation pipes.

Speed Is Essential to Success

The importance of mining and filling *quickly* at the Mt. Con cannot be over emphasized. A few stopes must still be mined with timber because rock bolts cannot hold the ore or the walls even temporarily. Most of the stopes would not stay open throughout production operations with rock bolt support alone. But, by mining with new methods and equipment, all selected to speed up the mining sequence, it is possible to mine 90 percent of the Mt. Con's stopes without timber!

The new methods and equipment include: (1) air leg drills and small diam bits (easy to handle and faster drilling); (2) ⅞ by 16-in. powder (faster loading); (3) eight to 12-ft cuts made with horizontal 12 to 16-ft holes (to minimize shattering of the back); (4) millisecond blasting (to break rock to easy-to-handle size); (5) 30-hp slushers and 48-in. wide scrapers (for faster mucking); (6) rock bolting for temporary support; (7) crib-chutes of special design, and (8) increased use of lateral and crosscut methods of sill development.

Some of the principle advantages of using hydraulic fill in Butte are listed below. They are not necessarily in order of their importance; either with regard to Anaconda operations or hydraulic fill operations in general.

Increased Efficiency: Since the switch from timbered and rock filled stopes at the Mt. Con, savings in material and labor have reduced stoping costs 30 percent and increased efficiency over 54 percent to 14 tons per man shift.

Improved Ventilation: In a deep mine like the Mt. Con, good ventilation is necessary and expensive. Improved ventilation means improved mine efficiency. The advantages of hydraulic fill with regard to ventilation are: (1) less fugitive air; (2) more positive control of air-flow; (3) less newly-exposed, warm mine faces required for the same tonnage—hence, less heat transfer to ventilation system, and (4) lower volume of air needed to adequately ventilate a stope.

Safety: Besides the overall improvement in ground support, hydraulic fill provides a firm, level working floor. Also, less open space results because the fill is poured to within a few feet below the mining face. (It was necessary at some stages of waste filling to have up to six floors open). Consequently hydraulic fill provides a safer working environment. Incidents of falling ground accidents are reduced and, since the miners can't fall any appreciable distance, serious falling person accidents are practically eliminated.

Mine Fires: Hydraulic fill areas act as a fire break. The fill system proved of inestimable value in a fire at the Mt. Con in 1956, because plant, pipe lines, communications and trained crews were ready for action. Also, the possibility of fires in mined out areas is virtually eliminated once the areas have been filled with suitable material.

Ground Stabilization: Unconsolidated types of fill such as waste rock, gravel or course sand have considerable void space which allows ground movement until the material is consolidated. Hydraulic fill is practically incompressible and provides an immediate and permanent support. It does not allow initial movement in localized workings or subsequent movement over extensive areas (such as allowed by the compression of timber and rock fill over several levels). This advantage is gained at a favorable cost. At the Anselmo mine, for example, the cost of in placing hydraulic fill is 71 cents per ton (or 35 cents per ton of ore) plus loading and transporting cost of 47 cents—a total of $1.18 per ton. This is lower than the cost of using alluvial sand at the Emma mine which is $1.98 cents per ton.

Hydraulic fill can also be used for temporary support or "preservation" of workings. For example, an opening which is not to be used for some time may be filled. Later the fill can be mucked out, mixed to slurry, and pumped to some other workings to be used again.

Pillar Recovery: Hydraulic fill undergoes cementation and stands well when adjoining pillars are mined away from it.

Simplified Mining Methods: New mining methods and ground support techniques are simpler as well as safer. Hence, miners require less training.

Subsidence Control: Hydraulic fill prevents subsidence that would occur if waste rock or coarse sand were used.

Miscellaneous: (1) supply is always adequate because one cu ft of milled ore makes two cu ft of fill; (2) tailings disposal problems decrease, and (3) improvements in mining methods such as multiple chutes, tire or track mounted loaders, etc., are feasible. Obviously, there are many more advantages, but space does not permit elaboration.

The major disadvantages of hydraulic fill are: (1) drainwater disposal; (2) drainage ditch maintenance; (3) maintenance of slurry and drainage pumps, pipelines, and rolling stock; (4) breaks in shaft lines; (5) difficulty of unloading frozen tailings in the winter, and (6) development waste disposal problems.

Anaconda engineers conclude: "It has been proved conclusively in Butte that the advantages of using hydraulic fill far outweigh the disadvantages. In fact, it is difficult to see how well-planned use of hydraulic fill could fail to pay off economically. As evidence of this, throughout the mining industry more mines are being converted to the use of hydraulic fill every year. It is becoming increasingly evident that such use is an effective method in cutting cost and improving the competitive position of selective mines."

They offer this bit of sage advice: "To reduce to a minimum subsequent difficulties in plant, pipelines, and underground filling operations, the planning and design of a hydraulic fill system should be carefully executed with the aid of as extensive a body of experimental data as possible."

The reader is urged to watch for an article by Richard M. Stewart, assistant to the director of mining research, entitled "Hydraulic Filling in Underground Mines," which will be published in a future issue of *Mining Congress Journal*. This article will present the highlights of the Symposium on Hydraulic Stope Fill, and will be particularly well worth reading.

TIMBER

To complete the Butte support picture it is necessary to point out that a considerable quantity of timber is still used at Butte. Anaconda has its own sawmill near Bonner, Mont., and an economical treating plant at Butte. The treating plant uses arsenic oxide as a preservative which is a by-product from the company's smelting operations.

The improvements in timber handling techniques described by T. S. Veazey, Jr., in the Dec. 1950 *Mining Congress Journal* article, "Packaged Timber Handling," have paid off very well.

The objective of the entire program of improving timber handling was to devise an efficient system to handle a unit-load package of timber from the sawmill to working place, thereby eliminating piece-at-a-time handling.

At the present time, all timbers are squared at the sawmill; no round timbers are used. Large lift trucks unload the packaged timber from railroad cars. The large units from the sawmill are mechanically repackaged into smaller units that can be handled in the small Butte shafts. (The small shafts are a major problem in this regard. New shafts will be much larger.) Packaged timber is stored in and distributed from a central yard that serves all the mines. Facilities are available to handle the packaged timber at shafts and stations.

There are many obvious advantages in mechanically handling several pieces of timber at one time instead of man-handling each piece over and over again at each step of its journey to the working place. To achieve an efficient, workable system which will provide these advantages, however, requires a great deal of planning and experimenting.

The author would like to express his sincere appreciation for the fine cooperation of The Anaconda Co., particularly in showing him around underground and allowing him access to the conclusions set forth in various unpublished company reports, without which this article would have been impossible.

The ROLE of RESEARCH In Marketing Metals

Combined with intelligent and aggressive development and promotion, research can help increase the consumption of metal products

By W. M. PEIRCE

Assistant to the Executive Vice President
The New Jersey Zinc Co.

THE word *research* means, both literally and practically, "to take another look." It is a word that was very little used before the first world war, but it is only the word itself that is new to the popular vocabulary. There have always been people who believe that everything should be left just as it is and that there is nothing new under the sun. There have also been those who believe that anything can be improved and that there are new things to be uncovered, and this is the attitude that sparks research.

Research is not universally well thought of, and research people are sometimes accused of being visionary and impractical. One must be visionary in a sense to have a new idea, so the first charge is true. As to the charge of being impractical, the first step in research is to find out whether an idea can be made to work at all; the second to determine whether it can be done at a cost that makes it economically feasible—in other words, whether it is practical. Since the proportion of ideas that survive both steps will always be small, the charge of being impractical is hard to scotch. Nevertheless, the successful research director does assess the odds before he selects the projects on which to place his bets. Having made a commitment, he faces at intervals what is often a more difficult decision—namely, whether the odds still warrant continuing. If he persists too long before admitting failure, he is a stubborn dreamer. If he quits and a competitor goes on to succeed, he lacks vision, courage, and pertinacity! It's a rough life, but luckily there will always be plenty of hardy, dyed-in-the-wool pioneers to spend all the money they can pry out of the financiers who distribute what profits the salesmen make out of the wealth produced by the operating men.

In short, it takes all kinds of people to make up an economy, and researchers are one of the kinds.

Time Has Changed Outlook

According to the Bible, Adam and Eve were thrown out of the garden for their proclivity to investigate—to say nothing of experiment—and certainly it is a fact that religion took a dim view of scientific investigation for many centuries. Some rugged individuals, nevertheless did investigate the laws of nature, and did seek means of improving man's lot, and gradually scientific investigation became respectable and proceeded at a steadily accelerating rate until it became a dominant factor in Western Civilization.

The thing that is new in the present century is that research is being conducted systematically and in an organized way by workers employed specifically to do research. This method of research has serious drawbacks, the principal one being that it tends to repress and restrain the ultra-imaginative individual who may often be chasing a will-o'-the-wisp but who now and then makes a revolutionary advance. However, the facilities required for modern research have become so complicated and expensive that team research, supported by large corporations, well endowed institutions, or the Government, has become the only practical approach in most fields.

Why Should the Metals Industry Conduct Research?

It may seem unnecessary to recount the achievements of research in the past generation since the most fantastic development of yesterday is looked upon as commonplace today. Nevertheless a few examples of what research has done for the metal industry in the past twenty or thirty years may not be amiss for, while these examples are not in the spectacular class of nuclear fission, they furnish more tangible evidence of why the metal industry should be concerned with research.

In the area of extractive metallurgy—if the author may choose his example from the area with which he is most familiar, zinc metallurgy—every major new production facility built since the first world war employs a process developed by research since 1910. The electrolytic process came first, then the vetrical retort, then the electrothermic, and last the blast furnace process.

In the field of metal utilization, let us start with aluminum. Every structural and architectural use of aluminum has been made possible by research into the mechanical, physical, and chemical properties of aluminum and its alloys. In the case of copper,

one can scarcely suppose that oxygen-free copper, beryllium copper, and many improved alloys such as Everdur —all products of research—have not had a potent effect on the tonnage of copper used. The second largest use of lead in tetraethyl lead is the result of research. Research by consumers which resulted in improved lead alloys for cable sheathing has for a long time held back the competition of other materials. Unfortunately for lead, aggressive research by the producers of other sheathing materials is threatening this market. Finally, the use of zinc for die castings, which last year was the largest market for zinc in the United States, was too small in 1920 to be separately reported. Today the alloys developed by research, improved casting methods, and better plating procedures—also the outcome of research—have brought this industry to a point where it consumes over 40 percent of all the zinc used in the United States.

To some people these accomplishments, although they have been economically important, seem too prosaic, and the research man not infrequently finds himself accused of throwing cold water on other people's ideas because he won't shoot for the moon. A zinc salesman, painfully aware of the color appeal of plastics, may seriously proprose a research project to develop a zinc alloy having a solid color through and through, as cast. Another wants a high zinc alloy of low density. The research man who explains to the first that the only way to color a metal is to change its surface to a nonmetallic compound, itself possessing color or capable of absorbing a dye, or the one who explains that for all practical purposes the density of an alloy is the density of the weighted average of its components, meets the reception of any bearer of ill tidings.

Research does not achieve miracles —though we see results that appear miraculous, such as radar. It cannot change natural laws. It can only seek an understanding of natural laws and a application of them to achieve the best answer to a specific problem. Research thus becomes a gamble, just as the exploration for ore is a gamble. Ore can be discovered only if it is there. Research can discover facts and combine them to achieve useful results, but it can't change the laws of nature. Since research is an expedition into the unknown, its very nature demands first that an intelligent investment in research be based on a commitment to a project of broad enough scope, and for a long enough time, to justify the hope of a useful outcome.

Many revolutionary discoveries have been the unexpected by-product of an investigation directed simply at a search for new knowledge, or have been almost unrelated to the original objective of a research project. Sound pursuit of research requires also the scientific curiosity to follow up valuable leads into unexpected areas and a willingness to exploit such discoveries.

Research on production methods is in the province of individual companies. Research on utilization can well be carried on by joint effort of the individual producers through trade associations

It Takes More Than Just Developing a Good Product

There are three distinct stages to realizing a return from research. First, the research must bring to light a product or a process that has potential value. The second stage, which is usually more expensive and may require a considerable period of time, is the practical development of the idea to a point of commercial utility. The third stage is the development of a market for the product or process.

Unfortunately, the old adage that "if a man develops a better mousetrap the world will beat a path to his door" is not true in this day of keen competition and supersalesmen. The best product in the world requires aggressive promotion and selling. The present generation wants curb service on everything from a milkshake to banking. This is not meant to imply that it is not easier to sell a superior product, nor that an unsatisfactory product can hold a market over an extended period. It means that, within a group of reasonably satisfactory products, the relative sales will reflect promotional effort and ability.

If we take a look at the metal industry, we will find that every one of today's metals has a field in which it is the best choice, and borderline fields in which it can serve but where one or two other metals are equal or better. Similar border areas will exist between metals and non-metallic materials. In these border areas, the business will go to the product that is most intelligently and aggressively sold.

The author has spent most of his career directly in research, and he believes wholeheartedly that research can be a good investment; but he is equally sure that to cash in on it, for every dollar spent on research an equally great or greater expenditure of money and intelligent effort is required to commercialize and sell the discoveries of the laboratory.

There have been periods during recent years when there was a widely held opinion that most, if not all, of the nonferrous metals would be in short supply for many years to come. In fact, there were those who argued that within a few years our supplies would be exhausted and we should be looking for substitutes. Today it should be abundantly evident that the problem is to stimulate consumption, rather than production, and that no traditional market—no matter how long established—is invulnerable to competition. At the moment, the imbalance of supply and demand is serious in the case of all of the nonferrous metals, and critical in the case of some. In this situation it is natural to ask whether research can help.

My answer to this has already been indicated. Research can help if intelligently planned and persistently continued, and provided it is backed up by development and promotion; but to avoid disappointment we must realize

The great market growth of aluminum is directly related to the fact that it has received the largest amount of research, development and promotion of any nonferrous metal

that the attainment of worthwhile results may take years rather than months. Anyone who doubts the value of research may well pause to note that, viewed in terms of market growth, the nonferrous metal that is in the best position, aluminum, is also the metal on which by far the largest amount of money has been spent for research, development, and promotion.

An attitude toward research sometimes encountered in a situation of the sort we are considering is that the cream has been skimmed and that further expenditure is foolish. This is an easy attitude to slip into and at times a difficult one to controvert, because it is in fact foolish to reinvestigate old territory unless you have better methods and tools at your command or unless prior work has been clearly inadequate or incompetent. But, remembering that a Patent Commissioner many decades ago wished to close the Patent Office because all of the inventions had been made, we must never lose our willingness to take another look.

Purpose of Research and Who Should Do It Main Questions

If we accept the fact that research can help, two questions arise: what direction should the research take, and who should do it. Research directed at the improvement of production methods with a view to lowering costs or improving quality, and thereby helping to meet competition from substitute materials and from foreign imports, is obviously a matter for individual companies.

Research directed at finding new uses or extending old uses for a metal presents a different problem. Such research is often done by an individual producer, but unless he can obtain patent monopoly, the only direct advantage that he will gain is a short-term head start in the new market. Indirectly he will of course benefit by whatever general improvement to the industry as a whole may result. There has been, therefore, an increasing tendency in England which now seems to be gaining in this country for the members of various industries to pool their efforts through trade associations in supporting research aimed at new markets. Such pooling of resources has the obvious advantage that all companies can contribute in proportion to their size. The smaller companies who are unable to support any independent research are thus afforded an opportunity to contribute, and so maximum financial support is brought to bear on solving the industry's problems. Furthermore, in the areas selected for joint effort, duplication can be avoided. Such duplication is almost certain to occur otherwise, since there will be problems of such urgency that the larger companies would each feel compelled to initiate a program of its own in an effort to reach a solution.

Unfortunately, there is a potential disadvantage which can offset the inherent economies of joint effort. Everybody's business is nobody's business, and a company is apt to pay less careful attention to projects to which it is contributing a thousand dollars as its share than to one that it is supporting alone to the tune of ten thousand. The answer of course lies in maintaining the effectiveness of every arm of the trade association organization.

In theory this is an ideal method of conducting research on the utilization of an industry's products; in practice it presents some problems. First of all, as previously pointed out, embarkation on a research program is not justified except with the determination of continuing it over a considerable period of years. The trade association must therefore be in a position to commit itself to such continuity of effort. Second, the problem arises as to whether an independent laboratory should be set up, staffed, and equipped. In the long run, this is the most efficient and effective way of doing research, but the initial investment is high and the project must be viewed in terms of a great many years to justify it. An alternative is to have specific projects carried out by one or another of the numerous research laboratories that do research under contract.

Having research carried out under contract has its good and its bad points. The capital investment required is limited to the cost of the special equipment required for the work. Competent supervision can usually be assured by selection of a laboratory having prior experience in the general field involved.

On the other hand, the junior members of the staff assigned to the project will require a considerable period of training before they become effective, and unfortunately there tends to be a high turnover among this group. Where it is practical for an organization to establish its own laboratory, there is the possibility of building up an experienced team capable of getting into action quickly on new projects.

Long continuing projects placed with contract institutions are subject to one of the same dangers that exist in a laboratory organized by the association itself. It is natural and inevitable that a team working on a project will see reasons for extending and perpetuating it to a point of diminishing returns. The advantage of doing work under outside contract is that it seems to be easier not to renew a contract than to cut off funds for a project in one's own laboratory.

The problems inherent within the trade association itself hardly need to be mentioned. In order to achieve maximum results, an industry-sponsored research program must utilize the background and experience of the technical staffs of the several companies to aid in the planning and guidance of the projects. The degree to which full cooperation can be attained will have a large influence on the success of the program.

Opposed to the idea of having the technical representatives of the member companies take an active part in planning the research program, the opinion is sometimes expressed that a fresh viewpoint is not only desirable, but that it should not be clouded by examining the past. With this latter thesis the author cannot agree. The investigator with the fresh viewpoint who cannot examine what others have done and profit by what they have learned — both the positive and the negative—without losing his own originality, doesn't have much to start

with. By the same token, those who have in the past explored a certain field now to be reinvestigated must, when they offer the benefit of their experience to the new team, welcome a critical examination of their data and conclusions. Such examination of the existing knowledge, to avoid needless duplication on the one hand and to stimulate new thinking on the other, is the mark of the competent research investigator.

The purpose of trade-association research will usually be to develop new markets or retain and extend old ones for the basic products of the industry. At times, such investigations will lead to modified products or even wholly new products compatible with the industry's existing field of activity. Not every company will be able or even wish to participate in some of the opportunities opened up, but if the cooperative effort is to flourish, every company must have the same chance for an even-Steven start in utilizing the results of trade-association research; there must be no offside plays.

LIA and AZI Engaged in Cooperative Program

The Lead Industries Association and the American Zinc Institute are committed to research programs aimed at widening the markets for lead and zinc respectively. They have pooled their interests to the extent of engaging a single research director who will divide his time in directing the programs of the two organizations.

AZI has set up a Technical Steering Committee composed of technical representatives from each of the producing companies, including Canadian, British, and Australian affiliates, and it is through this committee that the type of cooperative pooling of information for the planning and guidance of projects is carried out. The Steering Committee sets up working groups to give particular attention to specific projects.

Research on product application must be directed now and then toward meeting an immediate problem on a more or less "crash" basis. A large committee cannot be called together frequently or on short notice. Therefore, an executive group of three members of the AZI Steering Committee, easily accessible to headquarters, has been set up to consider such problems promptly and to expedite action by submitting a proposed course of action to the committee by correspondence.

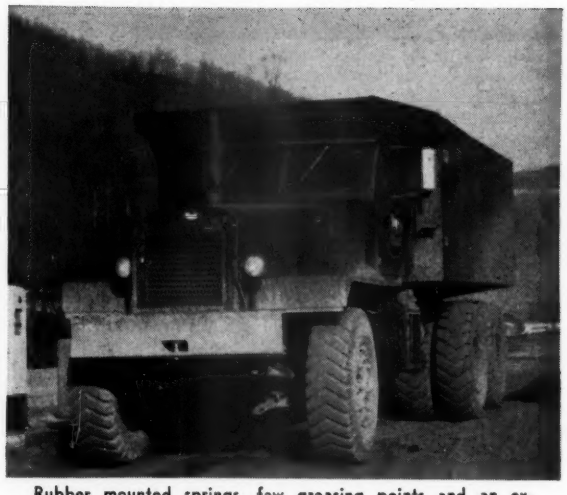
As a practical example of a number of projects already under way, it is well to mention a project initiated some time before the more extensive present program was proposed. It is a successful working model. The plating of zinc die castings needed study to find simpler, cheaper methods of attaining the desired quality. A small working committee of men technically experienced in the field was drawn from member companies. They furnished the technical guidance under which the AZI staff contracted for a research project which has continued under the supervision of the committee. The program, now in its third year, has reached a productive stage.

It will be the aim of the staff of the AZI, its research director, and the Technical Steering Committee, working together, to select problems on which productive research appears possible and to find the most effective means of conducting such research in each case.

The Lead Industries Association is operating along lines similar to those of the AZI.

These two nonferrous industries, lead and zinc, are thus initiating a well organized effort through their trade associations to *increase consumption through research.* It is my belief that such research will yield results, and that if these results are followed up with intelligent and aggressive promotion, the programs will pay dividends.

DOWNHILL HAULAGE Poses SPECIAL PROBLEMS



Rubber mounted springs, few greasing points and an excellent balance of component parts mean trouble-free operation with these 35-ton trucks

By ROBERT BUNCH
Partner
Bunch Construction Co.

A West Virginia strip operator, faced with the problem of hauling heavy loads down grades, finds good retarding equipment for trucks essential for improving safety, bettering brake lining life and promoting fast haulage

BUNCH Construction Co. uses Model L.R.S.W. Mack trucks on its stripping operation in West Virginia. These trucks have proven their worth and are doing a good job of hauling coal for the Boone County Coal Corp.

Before discussing the Macks, let us briefly examine the roads and coal seams at this strip mine.

Grades up to 18 Percent

On this job where there is one main haul road, the stripping contractor branches off the main road at the nearest and most convenient place to get to the strip pits. Secondary roads are built in most cases wide enough for trucks to pass, but if the road is just going to be used for a short period of time, it is usually constructed more narrow and passing places are put in use for the empty trucks returning to the pit. The first coal seam that is stripped is 80 to 100 ft above the main haul road and the secondary roads are constructed so that the grades will be between 10 and 15 percent—never more than 18 percent if possible.

There are three seams of coal being stripped. The first, as mentioned, is approximately 100 ft above the main haul road, the second 20 ft above the first and the third 20 ft above the second. The "ramps" from the second and third to the first seam level are usually very short and steep because they are used only for a short period of time. New ones are built as the operation moves around the crop line or coal seam. Why have so many ramps? The stripping firm uses the first seam level as its main haul road on the coal seams and it is easier and less expensive to maintain one good road than to try to keep three in traveling condition.

The roads on the coal seams are nearly always in the pits or on the level with the bottom of the coal that has just been loaded into trucks. There is a reason for this. With steep hills and the coal not too high on the hill, the spoil or overburden that is removed to obtain the coal is usually never pushed over the hill because of the danger of slides or damage to the main haul road to the tipple. When there is room for the overburden and no chance of damage, the overburden is leveled and a smoother and better road built out of the pit. The width of coal in the pits averages about 50 ft, but varies from 30 to 70 ft.

Truck Capacity—35 Tons

Getting back to trucks, the L.R.S.W. Mack is a short wheel base vehicle. For trucks carrying 35-ton loads, this is important for turning in narrow pits. The vehicles also are equipped with hydraulic steering — a big factor in short turning — and Cummins N.H.R.B.I.S. 300-hp engines which provide amply power to come back up the steep grade. Ten 16:00 by 25:00 tires, together with the power divider, give the L.R.S.W. sufficient traction on slick or muddy roads, and air-assisted clutches with a high capacity transmission mean easy shifting of the gears and enough power to keep the truck rolling.

Retarding Equipment

With the old type equipment, dropping down steep grades meant gearing the truck down in first or second gear—the motor revved to 1800 rpm or better. Brakes had to be applied in short intervals. All this extra wear and tear was an added cost on maintenance, and still the truck was just going five to ten mph. The L.R.S.W. Mack with a Hydrotarder

(Continued on page 71)

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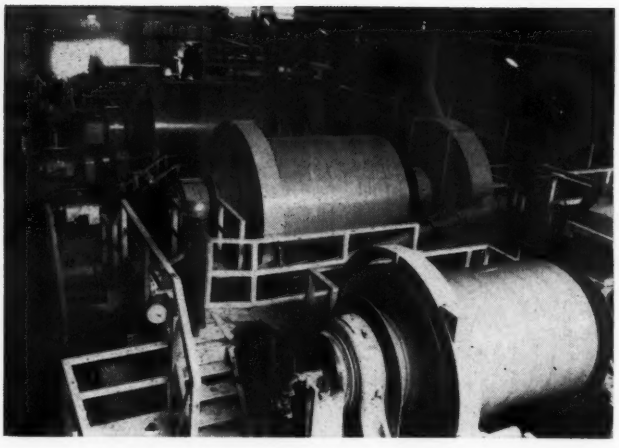


Fig. 1. Grinding section at Faraday Uranium Mines Ltd. in Ontario. Two partial-autogenous, nine by 11-ft pebble mills in center receiving feed from two six by eight-ft rod mills

By HARLOWE HARDINGE
President
Hardinge Co., Inc.

AUTOGENOUS GRINDING

Early operations were hampered by a lack of adequate control. Recent developments in methods of control have shown that autogenous grinding has many advantages to offer in mill circuits where this method of comminution is feasible

THE dictionary defines the word *autogenous* as "self-produced" or "independent." The method of grinding covered by this article is in that category. A tumbling type of mill is used, in which the grinding media for the material being ground is the material itself.

The methods of autogenous grinding may be classed as follows:

(1) Complete or fully-autogenous grinding: A relatively large-diameter tumbling mill is fed all the material just as it comes from the mine, or other source, and by self-communition reduces all sizes simultaneously to the desired fineness without the use of other auxiliary grinding devices.

(2) Partial-autogenous grinding: Separate means first reduces a major portion of the ore to a semi-finished size by conventional crushing and grinding methods. This partially ground material is then fed to a conventional size tumbling mill together with a previously removed sized portion of the crusher product which acts as grinding media.

(3) Modified-autogenous grinding: Auxiliary means are employed within the self-contained unit (such as the addition of a few balls to crush certain hard-to-reduce sizes in the mill), or the "critical" sizes are removed and sent to another device for reduction separately.

First Autogenous Tumbling Mill Tested in 1908

The use of ore or rock to grind itself is not new. Various means have been employed for many years, and in all probability back in ancient times. So far as the use of a tumbling type mill is concerned, there is a record of a test made by H. W. Hardinge which is recorded in the AIME *Transactions* of the Birmingham, Ala., meeting, October, 1908. Pre-selected, eight-in. pieces of magnetite were used as grinding media to reduce a feed of minus one-in. magnetite to 80-mesh product in one operation.

In 1916, barite ore was ground, using large lumps of barite as grinding media, in an eight-in. diam by 30-in. cylinder conical pebble mill. These large lumps of barite were removed from the feed; the balance was pre-crushed to one-in. size, and then fed to the mill together with the large lumps. Flint pebbles, the accepted grinding media at that time, were not employed, because the difference in specific gravity of barite and pebbles was in the order of 4.6 to 2.6. Thus the pebbles would tend to float. The use of barite lumps also reduced contamination. This mill ground wet and

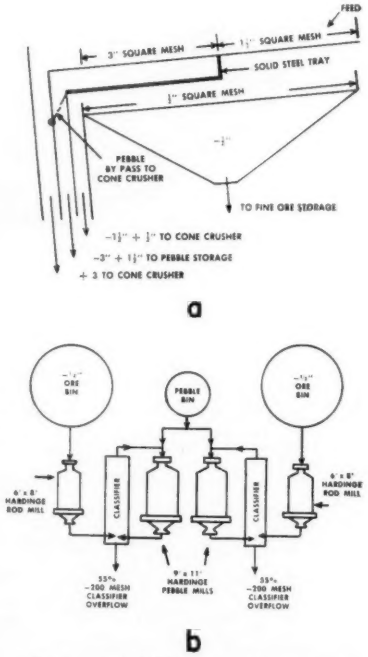


Fig. 2. (a) Pebble selection screen; and (b) grinding section flow plan at Faraday, and Bicroft Uranium Mines Ltd.

made a product of 95 percent minus 325 mesh at the rate of 1½ to two tph in closed circuit with a classifier.

Practice on the Rand in South Africa in a number of mills was in the partial-autogenous category. Coarse pieces of ore were screened from an intermediate crushing step, separately stored, and subsequently fed as grinding media to the tube mills, together with the balance of the ore that had been further crushed or received a preliminary grinding step by other apparatus prior to being fed to the tube mill. In some cases, a few balls were added to help reduce a critical size that would otherwise materially reduce the overall grinding rate.

In 1938, the American Nepheline Co. operated a dry grinding eight-ft by 36-in. Hardinge conical pebble mill. Three in. pieces of syenite ore were removed from an intermediate crushing stage and fed to the mill, together with finely crushed syenite that had been first reduced in a separate operation to approximately three mesh. A large grate discharge was employed to facilitate high circulating loads. The mill was operated in closed circuit with a vibrating screen. From 40 to 45 hp was required to grind the three-mesh feed at a rate of 4½ tph to a final product of three percent plus 20 mesh and 14 percent minus 200 mesh. The three-in. syenite pieces, which formed the pebbles, were consumed at the rate of 25 lb per ton. Such consumption would ordinarily be classed as unusually high and not economical. In this case, the high consumption made no difference since syenite was used as its own pebble charge, and of more importance, no contamination resulted.

Recent Installations Use Partial-Autogenous Method

A few years ago, Lake Shore Mines Ltd., took advantage of the partial-autogenous practice which was developed on the Rand in South Africa. B. S. Crocker (see references) described the development at Kirkland Lake, Ont., which resulted in a considerable savings as compared with the standard ball tube mill practice employed for a great many years previously.

At Lake Shore, in order to make the change from ball mill to partial-autogenous grinding at the least expense, the tube mills were enlarged and grates added, so the original motors could be employed and the mills could remain on the same foundations. A very good comparison of costs, operating characteristics, etc., could thus be made.

The mills were converted from high pulp level, trunnion overflow, five by 16-ft ball-tube mills, to grate discharge, low pulp level, six-ft eight-in. by 16-ft pebble mills. The mills were loaded to 50 percent of volume, and speed was altered to the same percentage of critical, namely 83 percent. The converted pebble mills were fed screened rock as a grinding media—first by predetermining the approximate pebble consumption and then maintaining the power at a maximum, as observed by the operator.

The capacity of the milling plant was 1000 tpd ground to 90 percent minus 325 mesh. An outline of the results at Lake Shore follows:

1. Steel ball consumption of 785 tons per yr was eliminated. This resulted in savings of $104,400 or $0.285 per ton milled.
2. The pebble charge changed much quicker than the steel ball charge. This allowed better determination of optimum media size which resulted in increased overall grinding efficiency.
3. The pebble mills operated best with a higher dilution. A moisture content increase of seven percent was found best for Lake Shore ore.
4. The hp per ton was the same as for an equivalent ball mill.
5. Capacity of the grinding media, either steel balls or pebbles, was directly proportional to their specific gravity.
6. Ball chips were eliminated thus making liner replacement easier. Liner costs per ton were only slightly in favor of the pebble mills.
7. Pebble mills, when equipped with a low discharge grate, used 40 percent more power and had 40 percent more capacity than when the same mill was operated as a high discharge or with trunnion overflow. Under identical conditions, and at the same percentage of critical speed, ball mills showed only 27 percent difference in capacity. Low discharge pebble mills were steadier and easier to operate than high pulp level discharge screened ore pebble mills.
8. Pebble mills, using screened ore, with low discharge arrangements were run at approximately 50 percent charge volume for maximum capacity and power consumption.
9. The relatively high pebble consumption resulting from high mill speed, high mill load, and low level grate discharge, was of no material importance, as the pebbles derived from screened ore were

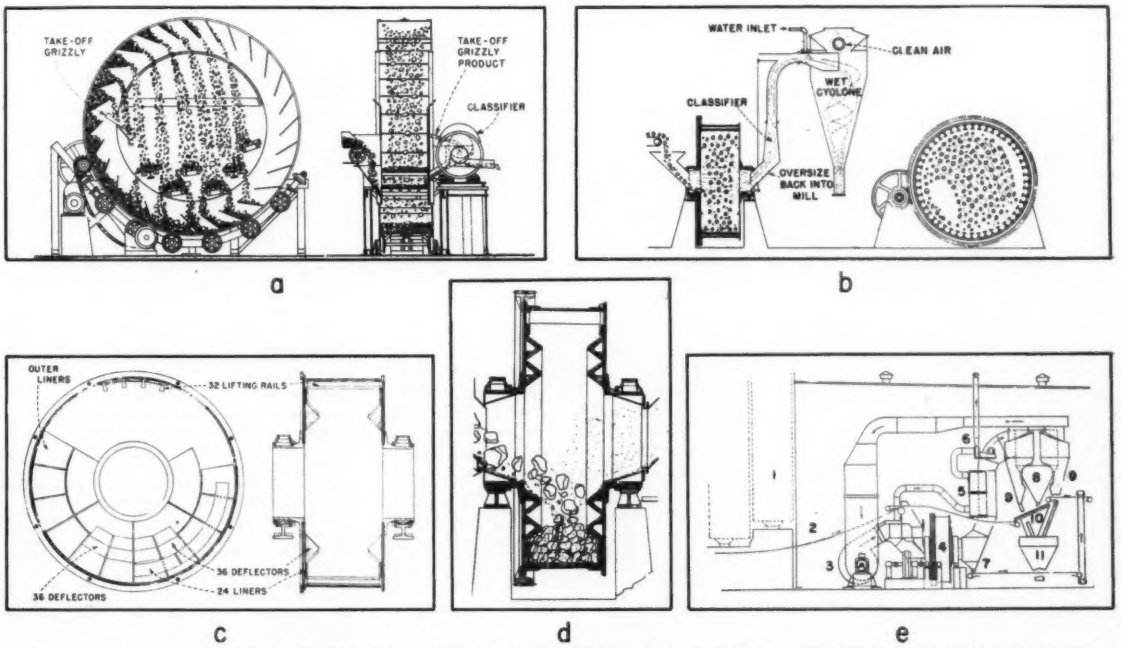
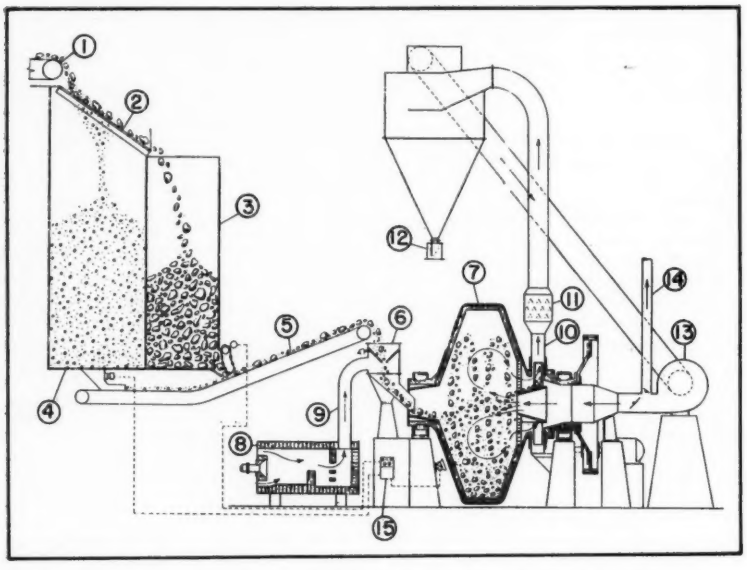


Fig. 3. (a) Hardinge-Hadsel mill, 1934 design; (b) Western-Hadsel dry high speed mill, 1936 design; (c) interior of Western-Hadsel mill; (d) cross-sectional view of Aerofall mill, and (e) general arrangement of Aerofall mill circuit at Benson Mines in New York State: 1. ore feed bins 2. feed conveyor 3. main fan drive 4. Aerofall 17-ft mill 5. Venturi scrubber 6. bleed-off fan 7. classifier 8. baffle separator 9. cyclones 10. screen 11. surge tank



Legend for Fig. 4

1. Run-of-mine feed or coarse crusher product
2. Adjustable bar grizzly
3. Bin for coarse portion of feed
4. Fine bin feed
5. Feed conveyor for recombined and proportioned sizes
6. Feed hopper for feed and hot air
7. Hardinge Cascade mill
8. Air heater used when feed exceeds 2 to 4% moisture
9. Hot air to mill, dries material while mill grinds
10. Moist air plus semi-ground product drawn out of mill
11. Air classifier rejects and cleans over-size
12. Finished product separated from air in collector and discharged to bin or conveyor at any convenient height
13. Air from system drawn into fan and blown back into mill
14. Moist air vented to atmosphere or other collector system
15. "Electric Ear" sound control keeps mill at constant grinding efficiency by automatically proportioning coarse to fine feed sizes for best operating condition.

Fig. 4. An illustration of the principle of first dividing the feed in a fully-autogenous system, then recombining it to maintain the principal size ranges in adequate supply

available in greater quantities than needed. Also, this reduced slightly the cost otherwise necessary to grind this same material by other preliminary devices.

10. Pebble consumption in screened ore mills was proportional to the size of the pebbles.

11. A six-ft eight-in. by 16-ft screened ore pebble mill with grate discharge consumed the same power and had the same capacity as a five by 16-ft high pulp level steel ball mill.

12. Screened ore rock passing a three by three-in. opening and retained on a two by two-in. opening produced pebbles in the mill 51 percent of which ranged in size between 1½ by ¾ in.

13. Soft ore made more rounded pebbles than hard ore and did not produce as many large intermediate sizes. It apparently cleaned up the small chips better. Grinding with soft ore as pebbles could start at a coarser pre-selected size than with pebbles made from harder ore.

The same method of operation is now being used in a number of other mills in Canada and the United States. Two of the most outstanding installations are at Faraday Uranium Mines Ltd. and Bicroft Uranium Mines, Ltd., near Bancroft, Ont. Both of these are completely new installations and not a changeover as was the case at Lake Shore Mines.

As a result of the experience gained at Lake Shore and elsewhere, Faraday's and Bicroft's mills were constructed to operate on the partial-autogenous basis. (A similar operation was also constructed for the North Rankin Nickel Mines Ltd., Northwest Territory.) The designed capacities for both Faraday and Bicroft were 1000 tpd.

Figure 1 shows the grinding section at Faraday, which consists of two six by eight-ft rod mills, preparing the feed for two nine by 11-ft screened ore pebble mills. The pebbles are made from pre-screened ore, using three-in. and 1½-in. screens. (See figure 2a.)

The plus three-in. ore and the excess of the minus three-in. plus ½-in. ore is crushed in reduction crushers and the rod mills to six to eight mesh. The product is then delivered to classifiers in closed-circuit with the pebble mills, with the final end product being 55 percent minus 200 mesh. (See figure 2b.)

Each rod mill consumes 80 hp, and each grate discharge pebble mill requires 240 to 260 hp. Dilution in the pebble mill is 34 percent moisture, or considerably higher than for normal ball mill operation and checks the findings at Lake Shore. Screened ore pebble consumption is 30 tpd of rock or 60 lb per ton. This is at a rate of about three percent of the total rated tonnage. At the start, pebble consumption was 100 lb per ton or 5 percent until the pebble load was adjusted and the pebbles became rounded.

The screened ore pebble charge is automatically weighed and fed into each mill, in accordance with the power rating on the mill motor which is kept at the maximum. If too many pebbles are added, power goes down—the load is then over 50 percent. The mill must then be allowed to grind until the load is reduced and the power, after first increasing slightly, then starts to decrease. By observation over a period of time, the operator can determine the pebble feed rate needed to maintain the maximum power reading for the mill motor.

Several Variables Added in Complete-Autogenous Method

As differentiated from the partial-autogenous grinding system described above, the complete-autogenous grinding system in effect comprises a unit that takes all of the feed as received and reduces it in one operation to the fineness desired, without the use of additional intermediate grinding means.

Complete or fully-autogenous grinding adds several variables that must be controlled or taken into consideration in order to make this method satisfactory and economically practical.

1. Since the maximum feed size is the dominant factor in reducing all other size ranges within the mill, this size range must be used to best advantage at all times.

2. Special attention must be paid to the physical characteristics of the material being ground.

3. During the process of crushing and grinding, the whole mass, from maximum size down to the final product, must all be reduced in a manner so that no particular size range will accumulate to an extent which precludes the possibility of economic reduction of the whole.

4. When grinding "dry", the material usually contains some moisture which, unless taken into account by drying either within the mill or outside of the mill, would make an otherwise practical operation wholly uneconomical. Wet grinding, if the subsequent process permits, would certainly be the answer in that case.

5. The complete or fully-autogenous grinding system, whether grinding wet or dry, tends to produce a more graded product than conventional methods using multi-step reduction such as a crusher, rod mill, ball mill combination. Retention time on the whole is less. This may or may not be an advantage, depending upon the subsequent process. A graded product, (a product where there is a more uniform gradation between the various sizes, and an excessive amount of fines is not present) is usually advantageous when grinding ore for concentration purposes.

6. When capacity requirements are sizable and constant observations by a skilled operator is too costly or impracticable, controlled means of properly aver-

aging the feed size is very important. The principles of segregating the feed into different size components, and then recombining to maintain an overall average size range over an extended period of time, resulted from the difficulties encountered with the early installations. These principles were not put into commercial use, however, until later (see figure 4). At the same time, and in conjunction with this preparation of the feed, automatic control of the feed rate in accordance with the grinding condition of the mill is essential to obtain maximum capacity and steady operation.

7. A different technique in testing the material to be ground in a fully autogenous grinding mill is essential. The test unit should be of adequate size to handle the coarse feed. Tests must be carried on sufficiently long, and with enough material, to reach the stabilized condition which results after all the rough edges are worn off of the feed and the grinding rates of different size ranges are established. A short test usually indicates capacity rates that are too optimistic. For both wet and dry fully autogenous grinding mills, proper mill shape, loadings, lining contours, feed and discharge arrangements, and methods of control are factors of major importance.

Early Mills Lacked Automatic Controls

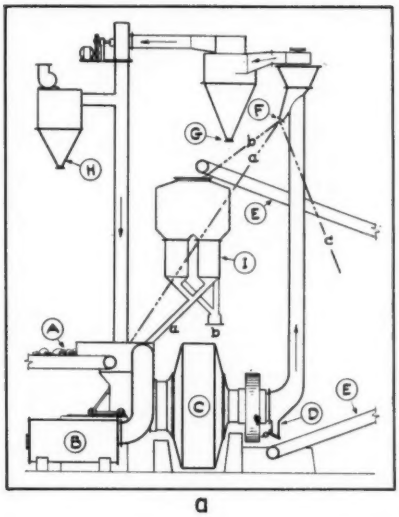
The Hardinge-Hadsel mill, as developed in the 1930's, was a self-contained, complete autogenous grinding device. It comprised a large diameter enclosed bucketwheel. Run-of-mine or coarse ore was fed directly to the enclosed buckets, which elevated the load and dropped it on stationary breaker plates. (See figure 3a).

From the rising side of the wheel, a so-called "takeoff grizzly" removed a portion of the load just as it started to drop from the buckets. The oversize of this grizzly dropped directly back into the mill, and the undersize was delivered by launder to a classifier. The oversize of the classifier was also returned to the mill by gravity, thus making a complete self-contained closed circuit system.

Three of the original Hadsel mills of the 1932 design were constructed, but two of these were converted to the Hardinge-Hadsel mill type in 1933. Before World War II, 12 Hardinge-Hadsel mills were constructed. Two were 24-ft diam; eight were 20-ft diam mills of various bucket widths, and two were 16-ft units.

Table I shows pertinent operating data of six wet-grinding autogenous Hardinge-Hadsel mills operating under various conditions. All of these units were grinding gold ore, none of which were again started up after World War II. Particular attention is directed to the commentary notes under "Remarks".

Even though technique then was not what it is today, several of these units were quite successful. Major difficulties were solved and changes in construction had materially reduced maintenance. Extreme capacity fluctuations due to the wide variations in feed size and grinding characteristics had been corrected, to a large extent, by employing the method of drawing ore from selected portions of the mine, and avoiding undue segregation of coarse or fines in the stockpile or bin by close observation at the mine, and by the mill operator. None of these mills were operated with automatic means to maintain conditions constant. If such means had been employed, the results would have undoubtedly been considerably better than those indicated.



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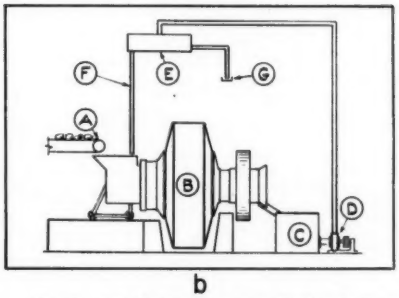

b

Legend for Fig. 5a

A. Feeder
B. Hot air heater when grinding damp ore
C. Hardinge Cascade DRY grinding mill
D. Coarse product discharge through "teeter column" if mill is to deliver a relatively coarse product. If only fine product is wanted, discharge can be eliminated here, also conveyor E
E. Conveyor (or elevator) to screens (or next process) where relatively coarse product is desired
F. "Gyrotor" air classifier coarse fraction:
   a. either back to feed end of mill for regrinding
   b. or, to screens for further sizing
   c. or, to next process
G. Fine product to next process
H. Dust collector fine product discharge
I. Screens for relatively coarse product
   a. oversize back to mill
   b. undersize to next process

Legend for Fig. 5b

A. Feeder
B. Hardinge Cascade WET grinding mill
C. Mill product discharge to sump
D. Solids handling pump
E. Size separation
   (a) classifier for relatively fine product
   (b) or, screens for granular or coarse product
F. Oversize return to mill
G. Product to next process

Fig. 5. (a) Fully-autogenous DRY grinding system; and (b) Fully-autogenous WET grinding system. Alternate methods of operation are shown

Many Difficulties Overcome in Progress of Dry Mill

During the period of the development of the Hardinge - Hadsel mill, A. D. Hadsel also brought out a modified dry grinding mill, using the principle of air sweeping in a relatively large diameter mill compared with the cylinder length; the object being to insure an adequate drop for proper autogenous grinding.

The early development of the dry Hadsel mill is illustrated by figure 3b. The original idea was to run the mill faster than the critical speed and allow some of the material to act as its own lining, at least that portion which would cling to the periphery. It was very soon shown that this was not economically sound, so far as grinding efficiency was concerned, and the speed of the mill was dropped to somewhere between 80 and 90 percent of critical. This mill was designed to be of the complete or fully autogenous type. Being a dry grinding mill, it was felt that the rate of wear on the lining would be considerably less than that encountered when grinding wet with steel balls.

The mill, due to the air-sweeping and natural segregating tendency of the material itself, was not able to operate at maximum capacity because of lateral segregation of the material. There were too many coarse sizes to break themselves up at the feed end, and too many fine sizes to act as a cushion at the discharge end. At first, annular rings made of angles were placed on the feed and discharge heads, as shown in figure 3b, to reduce wear and deflect the falling mass. These proved inadequate and were later replaced by large cast annular deflector blocks on the Harqua-Hala mill, such as indicated in figure 3c and also used on the Consolidated Mining and Smelting mills.

The first plant-size mill of the dry type was installed by Hadsel at the Draper mine in California, see table II. Hardinge-Western Co. at the Harqua-Hala mines, Salome, Ariz., then installed a 10 by five-ft mill.

TABLE I—AUTOGENOUS WET GRINDING HARDINGE-HADSEL MILL OPERATION DATA

	Beebe Gold Mining Co. Georgetown Calif. 1934	Slide Mines Boulder, Colo. 1934	Granada Gold Mines Ltd. Rouyn, Que. 1936	Wayside Con. Gold Mines Gold Bridge, B.C. 1936	Kootenay-Bell Gold Mines Salmo, B.C. 1935	Demonstration Gold Mines Ltd. Baguio, P.I. 1939
Mill Diam (ft)	24	20	24	20	16	20
Width (ft)	4½	5	2½	6	5	4
Ore	silicified schist and quartz	gold calcite and silicified schist	gold quartz	hard quartz mixed with clay	quartz and schist	sticky oxidized mn-calcites
Capacity (tons per 24 hr)	210	55	86	125	78 when feed 8 in. 50 when feed 1½ in.	250
Feed Size	minus 8 in. (grizzly)	12 in.	12 in.	8 in.	8 in to 1½ in.	12 in. (grizzly)
Product	0.7% + 80M 71% — 200M	2.1% + 28M 49.9% — 200M	55% — 200M	3.1% + 65M 78.4% — 200M	0.5% + 60M 87.1% — 200M	All-1⅝ in. (round hole)
Mill Motor (hp)	100	40	75	100	50	40
Mill Power Required	95	29	75	..	42	40
Mill RPM	2.67	3.3	2.67	3.3	4.25	3.3
Classifier	5 ft. wide Esperanza	3x8 Hardinge counter-current	4x10 Hardinge counter-current	6-ft. DF. Dorr classifier	4x10 Hardinge counter-current	take-off grizzly and 3x8 Hdge. c.c.
REMARKS			(a)	(b)	(c)	(d)

(a) This mill ran parallel to standard milling circuit, consisting of crusher, roll, and 5x7 ball mill, consuming total of 110-hp. Even though HH mill circuit had half the gold blanket area, the tails of HH circuit were 51.3¢, and crusher ball mill circuit 55.7¢, with a capacity average 78.3 tons per 24 hr., (33.4 hp per ton), while that for HH mill averaged 21.0 hp per ton for three-month period, just prior to the fire that destroyed entire mill. The ore was hard and not easily reduced below one in.

(b) Feed was usually deficient in coarse sizes, but when available, capacity exceeded that shown.

(c) When 8 in. feed was available, capacity was 78 tpd. When feed only 1½ in., then capacity was only 50 tpd.

(d) Mill used as crusher and scrubber for extremely sticky ore. Undersize of "take-off" grizzly 1⅝ in. round hole, delivered to 3x8 Hardinge counter-current classifier. Oversize was sent to ball mill circuit for final grind. Hardinge classifier fines delivered to ball mill classifier overflowing at 60%—200 mesh. Conventional crusher could not handle this ore, due to sticky nature.

Even with the side deflector blocks, a considerable amount of segregation took place. However, the operation was fairly successful so far as the mill was concerned—particularly because the ore was very dry.

Moisture in the ore had a great effect on the operation of mills of this type. An example of the effect of moisture is the operation of the eight by three-ft Dry Hadsel mill at the Draper Mining operation mentioned above. When the feed was quite dry, capacity was approximately 36 tpd and power consumption 28 hp; but when moist, capacity dropped to 20 tpd with power increasing to 45 hp.

The basic principle, as shown at the Draper mine, interested Cominco's management, and in 1936 they installed a small five-ft mill to test their various ores. As a result of this test work, several mills of this type were built and placed in operation.

A 12-ft diam by four-ft mill was installed at their Afton mine in Ontario and later removed to their Cordova, Ont., property. The latter operation continued until the start of World War II. These two dry operations of a Hadsel mill were among the first autogenous grinding systems to employ sound control of the feed. The "Electric Ear" sound control was instrumental in improving production in both instances. See remarks (c) and (4) table II. The fineness fluctuation was also decreased. Because the moisture in these ores was appreciable, hot air had to be supplied to dry the ore during the grinding process.

During this period, there was also installed at the Century Mining Corp. Ltd., in Manitoba, not far from Flin Flon, a 10 by five-ft dry grinding Hardinge Cascade mill, which incorporated features to reduce or eliminate the tendency for size segregation within the mill by employing the so-called "reverse current" system of air classification. The principle of regulating the amount of coarse feed sizes in the feed entering the mill, as well as being able to regulate the ratio of coarse to fine sizes made it possible to stabilize capacity rates. This was of material aid in increasing output and insuring a constant fineness. Use of automatic control, such as the "Electric Ear" which "listened" to the action within the mill, combined with the feed sizing arrangement, eliminated the major faults that hampered earlier development of complete or fully-autogenous grinding. Figure 4 illustrates this basic method of operation.

A recent application of the dry grinding complete or fully autogenous method is exemplified by the employment of a 17 by five-ft Aerofall mill at the Jones and Laughlin Steel Corporation's Benson Mines Division, in New York. After making tests in a small test mill, quite similar in principle to the basic idea shown in figure 3b and 3c a large unit was constructed.

The ore is a martite (hematite) iron, quite grainy in structure, and very readily broken to the natural grain size for liberation of the martite from the gangue at relatively coarse mesh sizes—namely minus eight mesh.

The original circuit had to be changed, as it was found that complete air-sweeping of all the material to the product collector was not practical for such a coarse product. As a result, 80 percent of the material discharged from the mill was dropped by gravity onto a conveyor and thence elevated to four eight-mesh vibrating screens where the undersize was joined with the 20 percent product from the product collector mixed with water, and delivered to the Humphreys spiral circuit. The oversize of the screens was returned to the mill for further reduction. It was found that where moisture over 1½ percent occurred in the ore, additional heat had to be supplied to dry the ore in the mill. (See figure 3d and 3e).

Choice of Dry or Wet Grinding Depends on Many Factors

The results achieved by several dry grinding operations with different conditions, ranging from 1936 to 1956, are shown in table II. The earlier operations covered fine grinding only, while that at Jones and Laughlin ground iron ore to a very coarse product. The most striking comparison is that of overall power consumption for fine dry autogenous grinding, as reported in table II, compared with power consumption for wet autogenous grinding at about the same fineness, as shown in table I. The same basic difference is evidenced here as in the case of dry grinding ball mills compared to wet grinding ball mills; namely, dry grinding requires somewhere between 25 to 35 percent more hp per ton of finished product than wet grinding for a given fineness. This does not include the additional

TABLE II—AUTOGENOUS DRY GRINDING MILL OPERATION DATA

	Draper Mining Co., Calif. Hadsel Hi-Speed mill. 1936	Harqua-Hala Gold Mining Co. Salome, Ariz. Hardinge-Western Dry High Speed Hadsel mill. 1936	Cominco Cordova mine, Ont. Dry Hadsel mill. 1940	Cominco New Golden Rose mine, Afton, Ont. Dry Hadsel mill. 1941	Jones and Laughlin Steel Corp. Benson mine, N. Y. Aerofall mill. 1955
Mill Diam (ft)	8	10	12	12	17
Width (ft)	3	5	4	4	5
Ore	gold	gold quartz	sulphide	gold quartz	martite iron (hematite)
Capacity (tons per 24 hr)	36 to 20	90	149	138	3360
Feed Size	broken run of mine —48M	8 in. 1.4% + 65M	9 in. bar grizzly	10 in.	—6 in. 3.7% + 10M
Product	(approx.)	62.0% — 200M	66.1% — 200M	66.5% — 200M	10.6% — 200M
Mill Motor (hp)	40	100	150	150	600
Mill Power Required	28 to 45	97	140	147	450
Mill RPM	23	21	19	..	16.2
% Moisture in Feed	varied	2	..	3.2 to 4.0	1½+
Air System Motor (hp)	5	15	..	..	600 + 50
Air System Power Required	3	10	..	18	340 + 50
Heat Used	None	None	pre-heated air	pre-heated air	3,000,000 BTU per hr.
REMARKS	(a)	(b)	(c)	(d)	(e)

(a) Capacity and power varied greatly with amount of moisture in feed. Speed was originally 27 rpm, but had to be reduced so mill could start with type of motor used.

(b) Bad lateral segregation of load in mill occurred at the start, which was partially corrected by using annular deflectors extending into mill from both ends, similar to arrangement shown in Figure 3c.

(c) Tonnage stated above was with use of "Electric Ear" sound control. Prior to its use, tonnage was 121.3 per day. Use of "Electric Ear" increased average capacity 22.8%. Steel replacement 6¢ per ton.

(d) Prior to use of "Electric Ear" sound control, tonnage was 118.5. After its use, 138 tpd, a gain of 16.4%.

(e) To make operation satisfactory, it was necessary to bleed off 80% of product at mill discharge and elevate by belt conveyor to —8M screens and return oversize to feed end of mill. System used electronic control to regulate feed. Heated air with moisture vent was necessary to maintain capacity when feed contained over 1½% moisture. Liner consumption estimated at 0.1 lb. per ton. Recovery higher and power per ton lower than rod mill section.

power needs for air sweeping when grinding dry.

While there is insufficient data for group comparison purposes between table I "Wet Grinding", and table II "Dry Grinding" (because the character of the ore and the fineness of grinds differed), the information that is available indicates that the same consideration should be given to the design of milling plants—whether to be wet or dry autogenous mills—as is given to wet or dry grinding ball mill or rod mill circuits. One should not try to compare the relative merits of a wet grinding autogenous mill with a dry grinding ball mill system or vice versa. Comparisons should be confined to wet versus dry circuits utilizing the same basic system.

It would appear that if the process following the grinding operation is to be dry, then dry grinding is indicated. But, if the process is wet, then wet grinding is preferable. A fully autogenous dry grinding system will have the advantage of somewhat lower liner consumption than the comparable wet grinding unit, but inasmuch as both have no or very little grinding media involved, that point is not too important. This may in some cases offset the advantage in the comparable wet grinding circuit, where the overall power consumption is lower. Also, when dry grinding, there is appreciable added cost of supplying heat to dry the ore which usually contains sufficient moisture to make this operation necessary.

The capital cost for a dry grinding milling system would generally be higher than for a comparable wet unit. The air conveying and classifying system usually costs more than the equivalent wet grinding classifier arrangement. Also, the dry grinding mill will be of somewhat larger size, due to the added horsepower required for the same grinding rate.

In situations where the complete or fully autogenous grinding system might have to be modified by the addition of balls if any objectional amount of critical sizes tend to build up, an additional evaluation must be made. Ball consumption in a dry mill is considerably less than for the equivalent wet mill. This then gives it the advantage of lower grinding media and liner cost per ton.

It appears that both wet or dry grinding autogenous milling systems (an example of each is shown in figure 5a and 5b) produce a comparable product as to fineness gradiation. Both products are apparently more graded, and have less extremely fine size fractions than those produced by the comparable crusher, rod, ball mill circuit.

Improvements Pave Way for Future Application

Different mill shapes will suggest themselves as well as methods of elevating and dropping the ore for best overall results. Closed circuiting arrangements are also an important factor. Only practical tests over an extended period of time will indicate what methods to employ for a particular autogenous grinding operation. Tests should also be made with feed sizes approaching those encountered in the field, and over a sufficient duration of time to insure that some so-called critical sizes do not unduly retard the grinding action and gradually accumulate in the mill. Lateral segregation in the mill must be avoided. Two methods can be used: One utilizes vertical heads with large annular deflectors which deflect and mix the ore as it drops, and the other employs conical heads, as in the Cascade mill (see figures 3d and 4), which deflects the ore when it first reaches the bottom after a long, clear drop. This latter shape is patterned after the known affect of the action that occurs in the feed cone of a standard short-cylinder conical mill where a violent mixing and grinding action is known to exist.

The technique of using material to grind itself is advancing rapidly. To state that autogenous grinding will completely supplant present well-established conventional methods, however, would be erroneous. Whether the partial-autogenous grinding system, using pre-screened ore as pebbles with supplementary intermediate grinding means, is preferred to the complete or fully-autogenous grinding system, using all the material just as it is supplied to reduce itself, depends on the character of material to

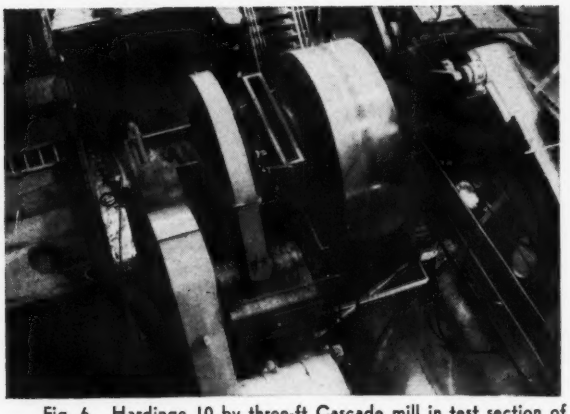

Fig. 6. Hardinge 10 by three-ft Cascade mill in test section of large concentrator. Mill arranged for either wet or dry grinding, shown here wet grinding in closed circuit with a spiral classifier. A 22-ft. diam by seven-ft wide Hardinge Cascade mill is now undergoing construction as a result of the test mill installation shown. This new mill will be capable of consuming up to 1600 hp. Fig. 7 (right). Eleven by four-ft Cascade mill designed to minimize segregation and obtain efficient reduction of all sizes simultaneously

be handled, as well as local conditions.

We have learned many things that we should not do. In the process, we have learned certain things we should and can do which are an improvement over past practices, and here is where autogenous grinding principles can be applied to advantage. It will, in these cases, be an additional contribution to the art of grinding and material treatment. Misapplications in the past have slowed the advancement of the art and there will be misapplications in the future. The art of autogenous grinding is in all probability now where the conventional system of stage reduction in closed circuit with sizing devices stood in the early 1900's.

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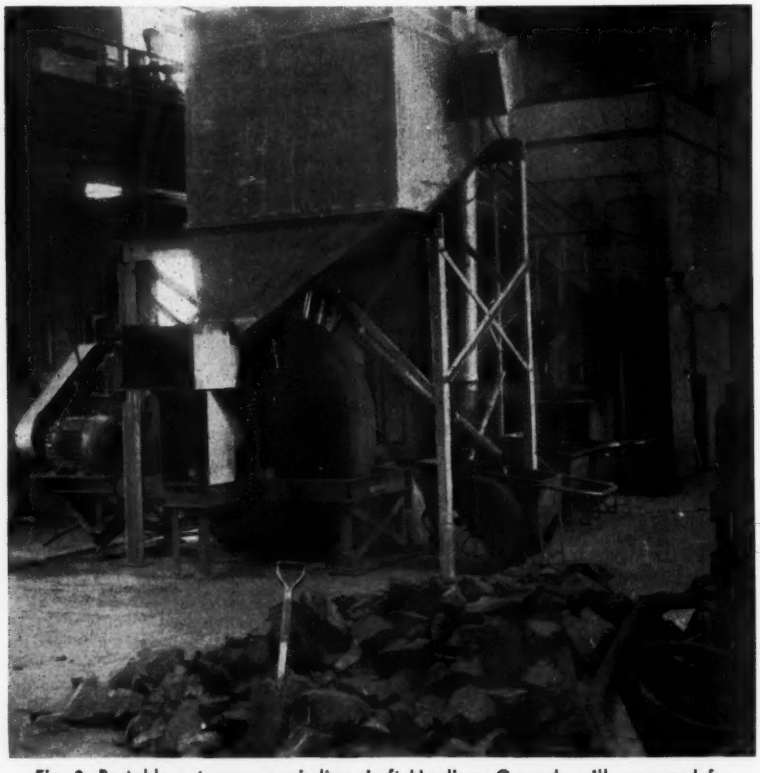

Fig. 8 Portable autogenous grinding six-ft Hardinge Cascade mill, arranged for either dry or wet grinding, in open or closed circuit, with screens or classifiers. Note the size of feed in the foreground

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Mine Lighting Developments

By ROBERT R. GODARD

District Electrical Engineer,
Frick District, Central Operations—Coal
United States Steel Corporation

IN 1955, prior to approval of fluorescent lighting fixtures for use in gaseous mines, a small experimental underground lighting installation using prototype units was made on intake air in United States Steel Corporation's Robena Mine, Greene County, Pa. Results of tests conducted at that time were reported to the National Safety Council and the Coal Mining Institute of America. It was apparent from data obtained, some factual and some nebulous, that trial on a larger scale was warranted.

Fixtures similar to the type used were approved by the U. S. Bureau of Mines in 1956 and by the Department of Mines and Mineral Industries, Commonwealth of Pennsylvania, early in 1957. Accordingly, 200 units with auxiliary equipment were purchased for illumination of a complete continuous mining section in Robena Mine.

Choice of a section for this operation was dictated largely by nearness to a source of a-c power so that neither high voltage transmission nor motor generator sets would be required. The section selected was located in 2½ Main Butt, adjacent to Colvin Shaft bottom and a convenient source of a-c power.

Ripper-Type Machines Used

Let's examine the mining plan and equipment deployment in this section before describing the lighting installation.

Development of a panel is accomplished by driving four headings perpendicular to the butt entry on 85-ft centers for a distance of approximately 2500 ft. Crosscuts are on 105-ft centers. Headings are 14 ft wide by approximately six ft high. Equipment used consists of four ripper-type continuous mining machines with rotary roof drills attached, four shuttle cars, four 30-in. wide by 600-ft long extensible conveyors, two 36-in. cross conveyors and one 36-in. butt conveyor capable of extension to 3000 ft, terminating in a car loading station. Two continuous mining machines are normally operated per shift. Shuttle cars serve as surge units between continuous mining machines and extensible conveyor for development on the straight, but make short runs when cross cuts are being driven. Rock dusting is applied on shift with slurry-type, wet rock dust distributors.

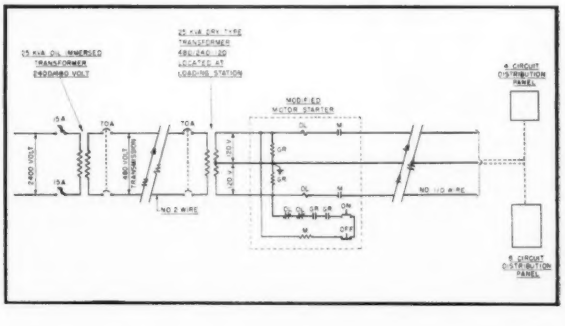
Upon completion of panel development, pillars are extracted by pocket and wing mining on retreat. Three extensible conveyors and one cross conveyor are removed from the section at this time to meet the need for greater flexibility and equipment mobility.

Branch Circuit for Lights Extended in Increments of 20 Ft

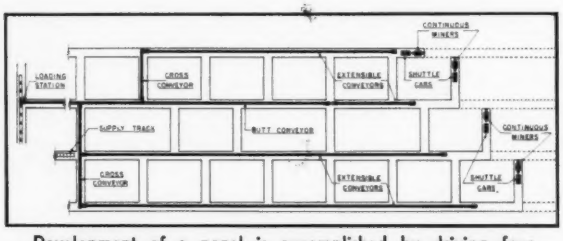
Power for lighting was obtained in an existing transformer room at the shaft bottom. Here, a 25-kva transformer steps voltage down from 2400 to 480 volts. Primary protection is provided by fused disconnects with secondary protection afforded by a 70-ampere, two-pole circuit breaker. Transmission from this point to the section is through approximately 2000 ft of two-conductor No. 2, neoprene jacketed cable, suspended on the tight side between trolley and rib.

At the section loading station, the 480-volt transmission circuit terminates in a circuit breaker and 25 kva, 480/240-120 volt, dry-type transformer. Secondary overload and ground protection is obtained through a modified motor starter, as shown on the diagram.

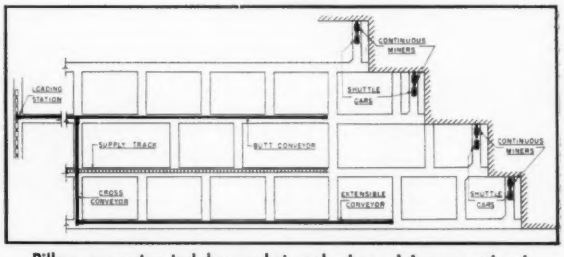
Secondary voltage is distributed in



Power transmission and distribution for the underground lighting installation at Robena mine



Development of a panel is accomplished by driving four headings perpendicular to the butt entry on 85-ft centers for a distance of approximately 2500 ft. Crosscuts are on 105-ft centers. Headings are 14-ft wide by 6-ft high



Pillars are extracted by pocket and wing mining on retreat. Note that three extensible conveyors and one cross conveyor have been removed from the section to meet the need for greater flexibility and equipment mobility

three-conductor No. 1/0 cable to two circuit breaker lighting panels, each equipped with 20-ampere branch circuit breakers. A four-circuit panel located near the loading station serves lights in approximately one third the section. The balance are fed from an eight-circuit panel located about 800 ft up the butt conveyor heading. The limits imposed by branch circuit protection, fixture current and cable size restrict the number of fixtures per circuit to a maximum of 25.

Branch circuit wiring is made up of a series of two 1-conductor No. 12 cords each equipped with a male plug on one end and two female receptacles in a common housing on the other. Short, two-ft cords with male plugs are installed on each fixture. Thus, as the branch circuit is extended in increments of 20 ft, a fixture may be plugged into the system at 20-ft intervals.

Brattice Men Responsible for Installation

The lighting fixtures used contain two 14-watt, T12, fluorescent tubes and are designed for operation from a 117-volt, 60-cycle source. Physically, they are 16½ in. long by 5½ in. in diameter and weigh 19½ lbs.

Lights are installed in the section on the tight side of all conveyor headings and along the last block of the section supply track. Spacing is 40 ft in secondary working areas with 20 ft spacing being maintained in such primary areas as face, shuttle car roadways, conveyor transfer points and loading station. Each fixture is supported by a spad hanger and "S" hook.

No personnel were added to the section to handle this equipment. Installation and relocation were assigned to the brattice men. Tube replacements and other repairs requiring opening of fixtures are performed as needed in the locomotive barn near the shaft bottom with existing personnel.

Lighting intensities differ somewhat from those obtained in Robena's earlier experiments due largely to difference in fixture spacing. They average ½ to 1 ft-candle with 40 ft spacing, but increase to 1 to 2 ft candles with 20-ft spacing. These levels are low compared to industrial standards. They do, however, provide a degree of visibility superior to that obtained from a cap lamp.

Voltage Regulation Poses Problem

The only serious technical problem encountered in the operation of this equipment has been that of voltage regulation in the distribution circuits. Original calculations based upon 120-volt supply, circuit resistance and lamp current yielded fixture terminal voltages varying from 104 to 118 volts. These values were found optimistic in practice due largely to variations in plug and connector resistances. Thus, it has been found necessary to adjust transformer taps periodically as the section advances or retreats. Since this is a stepped rather than continuous variation in voltage, it has produced abnormal potentials on some fixtures in the system for varying lengths of time, resulting in lower than desirable tube life.

There are two solutions to this problem. One is relocation of the section transformer to a point closer to the center of the load. The second is the use of 230-volt fixtures, now available from two manufacturers.

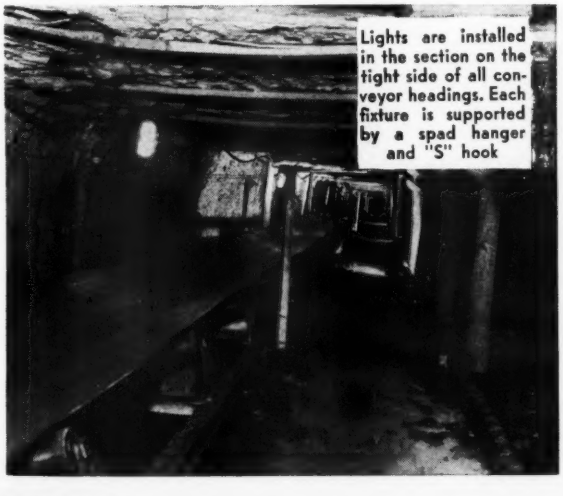
Do Advantages Justify the Expenditures?

As might be expected, the introduction of a full-scale lighting system was met with mixed emotions by the men in the section. Some like it, some objected to glare and others were non-committal. The firm's experience is well summarized in an extract of a report given earlier this year by Jim Flynn, Superintendent of Robena No. 1 Mine:

> "With the installation of an experimental underground lighting system in 2½ Main in August 1957, the inherent attitude of opposition to anything new was encountered with the working personnel. Complaints such as blind spots, glare, and temporarily reduced vision in moving in and out of lighted areas were encountered. However, I am pleased to say that these complaints have now almost completely stopped. This installation was made in one of our better sections where there had been a good safety and production record. In view of these facts, there has not been a noticeable increase in our production or improvement in safety which we feel would have, without doubt, evidenced itself had these lights been installed in a section with less favorable conditions. Although there have been no radical changes to date, it is felt that the benefits derived by the maintenance force and the tendency towards better housekeeping are evident."

The logical question to be asked by any operator is: "Do the advantages justify the expenditure?"

Frankly, management has not yet proven this point. There appears to be a need for further testing under poorer conditions before an accurate evaluation can be obtained. Beyond any doubt, higher productivity per man and more efficient utilization of personnel and material is a necessity in this day of rising costs, and better illumination can be a powerful tool in attaining these goals.



Lights are installed in the section on the tight side of all conveyor headings. Each fixture is supported by a spad hanger and "S" hook

Lighting fixtures used contain two 14-watt, T-12, fluorescent tubes and are designed for operation from a 117-volt, 60-cycle source

Steel Raise Liners

By R. W. BRAUND
Manager, Michigan Ore Division
and
R. L. BALCONI
Superintendent, Tracy Mine
Jones & Laughlin Steel Corp.

Maintenance of wood lined raises at the Tracy mine was too expensive. After investigation it was found that steel raise liners reduced maintenance costs and almost eliminated dangerous hangups

JONES & Laughlin Steel Corp. owns and operates the Tracy mine on the Marquette Iron Range in Negaunee, Mich. This underground operation has a rated capacity of 1,000,000 gross tons per yr of direct-shipping, medium hard to soft hematite iron ore. The mine operates the year around, stockpiling the winter production and shipping through three lake ports during the summer shipping season.

The mining operation is served through a vertical shaft. Six levels will be required to mine the four known orebodies. The orebodies exhibit typical Marquette Range structure wherein the ore occurs variously in synclinal troughs, in fault-dike troughs, or as sheets or sills on interbedded slates near the footwall. Dikes frequently cut transversely through the ore deposits. At the Tracy mine all of the orebodies pitch toward the West. Typical cross-sections are shown in figure 1.

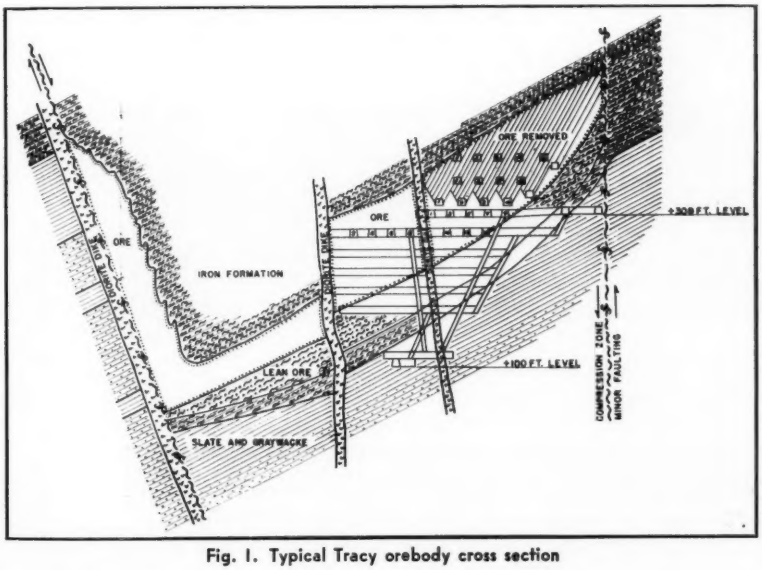


Fig. 1. Typical Tracy orebody cross section

Since this operation must ship ore without benefit of mixing it with other ores for grading purposes, it is necessary that daily production be on or close to grade. Under these conditions it is mandatory that a selective method of mining be employed; accordingly, the sublevel caving method of mining is used for most of the production. In areas where local conditions permit, a portion of the production is mined by sublevel stoping or by block caving methods.

Main levels are at 200-ft intervals, with drifts in the footwall and crosscuts to the orebodies. The initial development for sublevel caving in selected "blocks" of ore consists of (1) a double compartment raise for ventilation, travel and supplies, driven from level to level, and (2) a single compartment ore pass, with suitable connecting subdrifts at proper elevations. All ore passes are cribbed and start from loading subs driven directly over the back of main level openings. The ore is scraped from these loading subs directly into cars to be hauled to the hoisting shaft.

Wear on Hardwood Raise Lining Excessive

The mine is rather wet and the ore, being earthy, readily absorbs water to the extent that it can become quite plastic. Experience has proven that ore of this nature cannot be stored in cribbed or plank lined raises as this usually results in serious hangups. The loading subs mentioned above provide needed storage area thus eliminating the necessity of storing ore in raises.

Depending on the location of a main level drift or crosscut with reference to the orebody, a raise may penetrate material ranging from quartzite to decomposed slate, cherty iron formation, or shipping grade ore. Physical conditions may very from dry to very wet. Because of these variable factors and to achieve conditions of max-

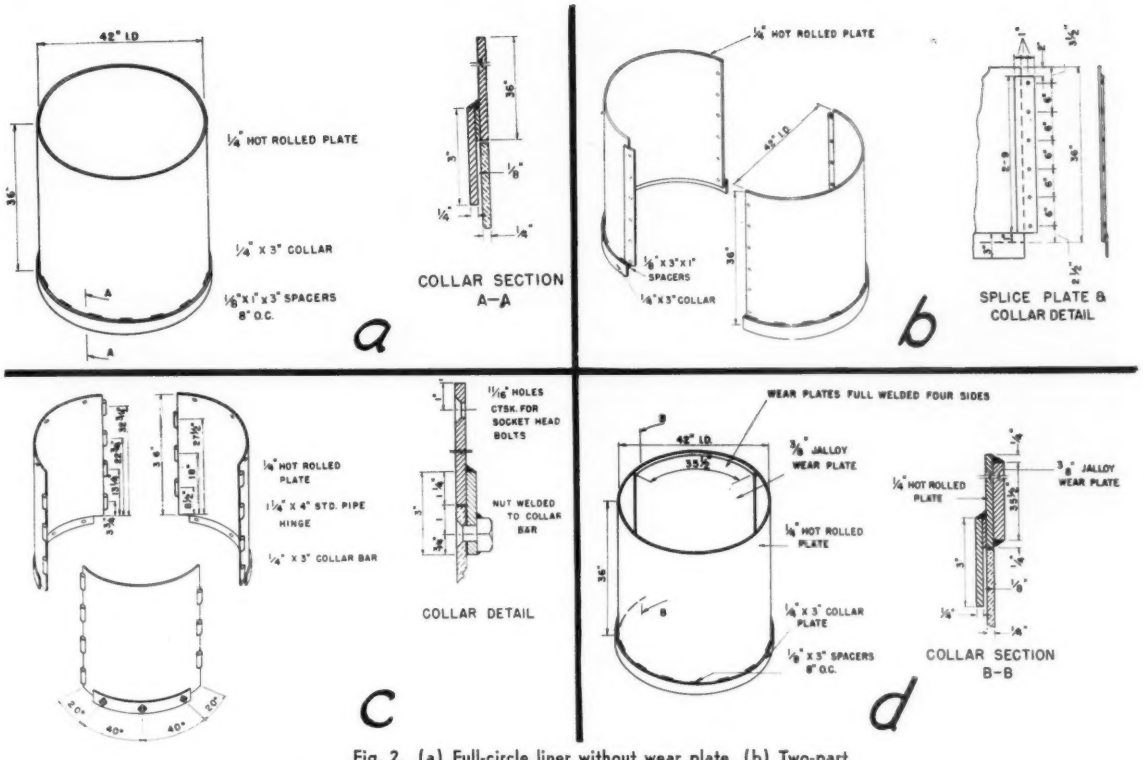


Fig. 2. (a) Full-circle liner without wear plate (b) Two-part liner (c) Three-part liner (d) Full-circle liner with wear plate

imum safety all raises are cribbed and driven at an angle of from 10 to 25 degrees from the vertical. Cribbing material for ore passes is untreated round hard or soft wood of suitable size. Ventilation raises of a semi-permanent nature are cribbed with treated square hardwood cribbing.

Many of the ore passes extend from level to level and, in some instances, a tonnage in excess of 300,000 gross tons of ore will be passed through the bottom one-third of the raise. It had been customary in long raises of this type to line the lower 150 ft of raise completely with two-in. hardwood plank. When passing upward of 400 tpd of ore through such a raise it was found that, after about two weeks of service, continual weekend repair was required. This usually entailed high support service charges such as hoistmen, foremen, etc. Occasionally eroded sections were undetected for sometime; when finally noticed serious damage had occurred requiring extensive repair with resulting loss in production. Quite frequently on operating shifts, a plank would be torn loose and become jammed crosswise in the raise causing a dangerous hangup. At other times, a raise would become plugged with ore necessitating water flooding from the top to start the ore moving. Aside from operating time lost, such hangups would suddenly release with devastating results in the loading subs below; the release would also create a very serious safety hazard to operating personnel in the immediate area. Accordingly, planked raises were kept empty—further accelerating wear of the raise lining.

Steel Raise Liners Tried

As a result of such experience it was decided to investigate the possibilities of using a raise liner other than planking that: (1) could be readily installed in cribbed raises; (2) would be fairly wear resistant; (3) could be easily repaired, and (4) would pass ore freely.

Many types of lining, from concrete through rubber were investigated. After due consideration it was decided that steel provided the greatest possibilities. Accordingly a planned variety of tubular steel liners were designed. (See figure 2a and 2b.) A relatively small number of each type were ordered for trial purposes, and the resulting bids from outside fabricators were quite high due to small lots and use of warehouse steel. Bottom or base plate support sections were fabricated in the mine shops. Data on these liners are included in table 1.

Initial installation costs of liners reflect in part the inexperience of the crews and the necessity of doing this work with minimum interference with production. This entailed considerable weekend work with high support labor costs at overtime rates.

It was planned to use the full-round section in Raise No. 1. The procedure was to hoist the liner through the supply raise to the proper sublevel and then lower it into the ore pass. Considerable difficulty was experienced in hoisting and lowering the sections due to jamming. Skids were then field fabricated to speed up this work. The first raise was completed with a mixture of full and split section liners. The space between the round steel liners and the square cribbing was filled as installation progressed by scraping available material into the raise from one of the subs above. This material was directed to the area surrounding the liner by use of a removable cone cap placed on the topmost section. The lining was terminated at or immediately below a sublevel for convenient access in the event a plug-up occurred at that point. To provide free flow into the liner for the falling production ore, and to eliminate damage to the upper edge of the lining, the tubing was capped with a funnel-shaped weldment constructed of heavy plate.

Wear Plate Needed in Footwall Portion of Lining

After several months of continued use the footwall portion of the liner showed considerable wear and it became apparent that a wear-resistant

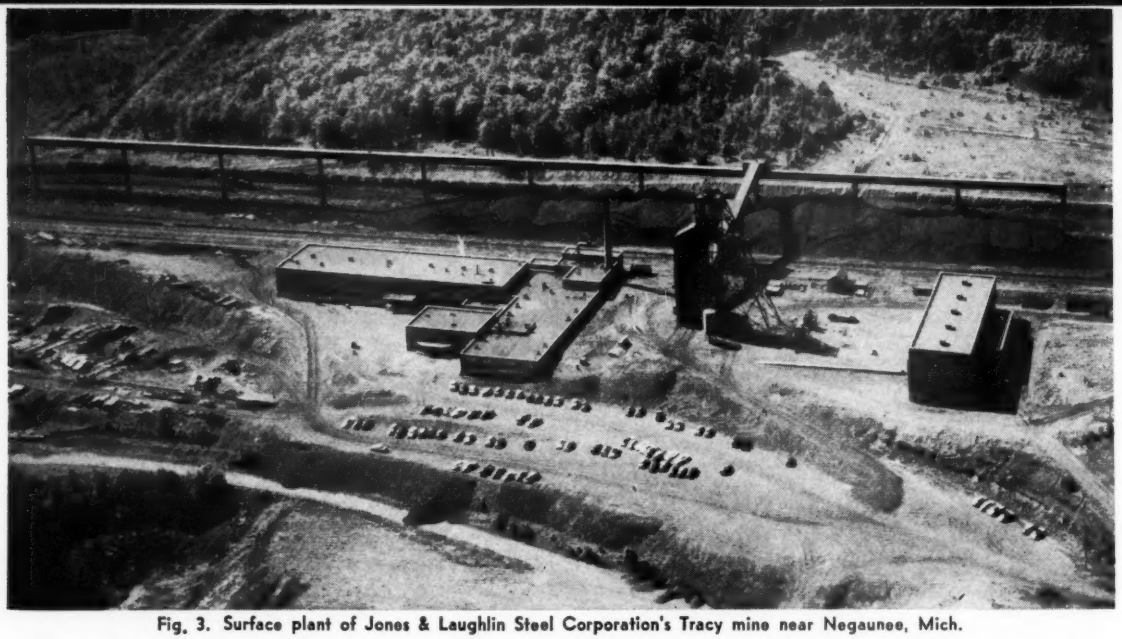


Fig. 3. Surface plant of Jones & Laughlin Steel Corporation's Tracy mine near Negaunee, Mich.

plate was needed on this portion of the tube. Consequently, a warehouse order of ⅜-in. Jalloy half liner wear plate was rolled by an outside contractor and the segments were welded in place by the mine crew. Aside from difficulty of access, water running down the raise was the greatest hindrance. This condition was partly overcome by inflating a truck inner tube against the liner above the work area, thus permitting collection and diversion of the water. It was readily apparent that all future wear plates should be installed at the time of liner fabrication thereby eliminating the excessively high field installation cost.

Jones & Laughlin's Jalloy No. 3 is used for wear plate in the raise liners. This is a general purpose steel which is capable of being heat treated to excellent physical properties. In comparison with ordinary hot-rolled mild steel, Jalloy No. 3 in the as-rolled condition offers good resistance to abrasion or wear. When heat treated to a Brinell hardness of 340 and upward it will give optimum results in abrasion resistance.

Due to the difficulty experienced in installing the full and half-round raise liner sections as described, it was believed that perhaps some of these troubles could be eliminated by the use of three part liners. A new section was accordingly designed. (See figure 2c.) It was expected that the higher fabrication cost would be offset by lower installation costs. Data on a small lot of the three part liner are given in table 2.

The three-part sections had been fabricated before it became apparent that wear resistant liner plates were needed in the lined raises set forth in table 1. Once again it was necessary to purchase and roll these wear inserts in a relatively small lot at high cost. This time, however, the wear plate installation was completed in the shop before the sections were sent underground. It was found that the three part liners handled with less trouble; yet there was some difficulty in assembling the several parts due to distortion. In some cases the men preferred to assemble the three sections at the top of the raise and lower the section into the raise as a unit, as in the case of a full round liner. From this, it was concluded, that the ease of handling prior to final placement in the raise did not justify the added initial cost.

TABLE NO. 1

	Cost per Lineal Foot		
	Raise No. 1	*Raise No. 2*	*Raise No. 3*
Installed footage	78 ft.	42 ft	78 ft
Diameter and length	42 × 36 in.	42 × 36 in.	42 × 36 in.
Full-round or two-part unlined ¼-in. plate	$18.00	$18.00	$18.00
Installation cost including overhead	25.60	32.70	38.50
Jalloy ⅜-in. half-round liner installed in raise	13.00	10.00	14.00
TOTAL COST PER FOOT	$56.60	$60.70	$70.50
Ore Produced—Tons	117,000	68,000	315,000*
COST PER TON—TOTAL LINING	$.0377	$.0375	$.0175

* Additional tonnage to be passed through lower 25 ft of this raise. Lining still in good condition.

TABLE NO. 2

	Cost per Lineal Foot			
	Raise No. 4	*Raise No. 5*	*Raise No. 6*	*Raise No. 7*
Installed footage	69 ft	42 ft	50 ft	74 ft
Diameter and length	42 × 36-in.	42 × 36-in.	42 × 36-in.	42 × 36-in.
Three part—⅜-in. mild steel plate	$33.93	$33.93	$33.93	$33.93
Jalloy ⅜-in., ⅓ liner wear plate	14.00	14.00	14.00	14.00
Installation	22.50	22.50	15.00	15.00
TOTAL COST PER FOOT	$70.43	$70.43	$62.93	$62.93

TABLE NO. 3

	Cost per Lineal Foot
Installed footage	75 ft
Diameter and length	42 × 36-in.
Full-round, ¼-in. mild steel with ⅜-in. Jalloy, ⅓ liner wear plate by prime contractor—FOB mine	$25.33 low bidder
Installation cost	15.00
TOTAL COST PER FOOT	$40.33

Raise Maintenance Costs Reduced

After having progressed from full-circle, to two-part, to three-part sections, the results of each design were

compared. A decision was reached to return to the original full-circle liner of ¼-in. mild steel, with a ⅜-in. Jalloy one-third inner wear plate, welded in by the prime contractor. Should an unusually difficult situation arise in some particular raise, a two-part liner could be made in the mine shop by cutting a full circle liner in half. Scrap rods would be welded to the full liners prior to cutting for the purpose of preserving the original shape until installed. This would prevent handling damage common to split liners that frequently resulted in assembly difficulties. It was further agreed that the next purchase would be in an amount sufficient to warrant mill order steel prices.

Figure 2d shows the design now in use; this is essentially similar to the design in figure 2a. The pertinent data is set forth in table 3.

In summary these liners have been developed to meet specific needs of the Tracy mine. Ore raises are cribbed for both safety in driving and ground support. The ore is earthy with occasional large chunks. Much of the production must be dropped a full 200 ft to the next lower level. To prevent hangups, raises were usually run empty with consequent high maintenance costs particularly in the bottom 75 or 80 ft.

Steel tube raise liners have materially reduced raise maintenance costs; inner liners made of abrasion resistant steel are a must in the bottom third of the liners. In areas where the ore is somewhat granular, raises may now be filled completely with only little danger of hangups. In other areas, except where unusually wet, 25 to 40 ft of ore can be stored in the raises, with little danger of plugging. When plugs do occur it is noted that response to top flooding is much faster, with less damage potential to the loading subs below because less water is used.

It is now standard practice to line the bottom portions of all raises at the Tracy mine.

MAINTENANCE OF A-C CONTINUOUS MINING MACHINES

(Continued from page 43)

of Sunnyside's a-c continuous mining machines. The firm uses 500 ft of No. 1 three-conductor type G cable on each machine. Whenever these cables have over three or four splices, they are exchanged and sent to the outside shop for repairs. Management strives to keep 460 to 480 volts in the working sections at all times. Power from the 200 kva transformer to the junction box is transmitted through No. 4/04-conductor rubber covered cable made up in 200-ft lengths.

Working sections are extended as far as 1200 ft from the transformer. All of the face equipment is protected by one of the two types of ground fault relays being used at Sunnyside Mines.

Of the first two continuous mining machines in operation at Sunnyside, one was a-c powered and one d-c powered. From the experience management had, the a-c machines were found to have about 50 percent less maintenance due to electrical and motor failure. The a-c system is also superior to the d-c as a safety feature because of the quick acting ground fault relays on all face feeders.

Water System

The water spray system for dust control has two 1-in. hoses in parallel so that each hose takes care of six spray blocks. These spray blocks are placed in the most practical position to best control the dust problems. The sprays are fed by the mine water pressure of 200 lb. Due to the impurities found in the mine water, it is good practice to turn the handle on the disc type filter frequently and to dismantle filters for cleaning at convenient times to prevent sprays from becoming obstructed.

General Maintenance Practices

Continuous mining machines are brought to the outside shop on the average of once a year. While in the shop they are completely torn down and every part of the machine is given a complete overhaul. This overhaul time averages around 200 manshifts, or 1450 manhours, and costs in the neighborhood of 17,000 to 25,000 dollars. Upon completion of the overhaul a date plate and number is welded on a convenient place on the machine and a file card is kept at the shop on the repairs and changes made to each machine. This has proven very beneficial in checking on the life of chains, sprockets, bearings and other parts, and also as a comparison of rebuilt parts against new ones.

The firm also keeps extra package units at the outside shop, such as gear cases, spare clutches, reduction units, hydro-jacks, ripper chains, conveyor chains and spare motors for each unit on the machine. This enables management to send in complete units to any of the three mines for quick repairs.

DOWNHILL HAULAGE POSES SPECIAL PROBLEMS

(Continued from page 54)

comes down the same grade in fourth gear, motor turning from 1200 to 1500 rpm, without using the brake and at a speed of 18 to 20 mph. The truck can be slowed to 5, 10 or 15 mph as the driver chooses by simply applying more pressure on the Hydrotarder.

The Hydrotarder is a water brake which fits around the drive shaft. When applied, the device slows the truck to the necessary speed wanted, in accord with the condition of the road. With steep grades and heavy loads, the Hydrotarder is essential as a safety factor and brake lining saver. In addition, Hydrotarder-equipped trucks can travel down grade at much greater speed with safety, where the braking is handled by water friction methods on the drive shaft and the truck brakes are left cool for use in stopping or emergency.

Although the Hydrotarder requires some maintenance, such as replacement of seals and occasional disc, Bunch Construction would not want to operate without it or some equally good retarding equipment.

Power Divider

The Mack bogie is proving to be all that is claimed for it in performance, stamina, tire life, capacity and trouble-free livability. Its performance is largely due to the Mack power divider, which is used in two types. The first is the inter-axle type used as a third differential and the other is the carrier type replacing the standard differential in rear axles of off-highway type of trucks. Both are similar in design and operate on the same principle. Performing as a true differential, the Mack power divider differs from conventional types in that it contains no gears, exerts no end thrust and is capable of distributing the torque unequally. It is not a friction device or a differential lock, but is simply a cam-and-plunger differential with a torque bias toward the side offering the greatest resistance.

The power divider's livability is assured because excessive loads are never imposed for the percentage of torque bias. The percentage of torque impressed on the side retaining traction is predetermined in the design to provide enough torque to keep the vehicle moving, but not enough to over-stress the parts.

Tire life is excellent because of the non-skidding properties of the drive and the complete flexibility of the Mack bogie. The springs are used as lower members of the parallelogram and are designed with high camber to allow side-sway. When centrifugal force causes the load to shift toward the outside of the turn, the outer spring deflects while the inner spring retracts. This action creates its own steering and prevents a great deal of tire scuffing.

Trouble free operation is accomplished by rubber-mounted springs, few greasing points and a wonderful balance of component parts.

Combination Belt

It is doubtful if the question of rail haulage vs. conveyor haulage will ever be fully settled, but combination haulage has been the answer to the need for efficient transportation at many operations. Two authors tell why their respective companies went to combination haulage, and what happened when they did

Contour Type Mines

By MACK H. SHUMATE
Assistant General Manager
Truax-Traer Coal Co.

THE problem of comparing all-belt haulage with a combination setup is difficult. Operating conditions of a particular property usually dictate the successful application. The trend toward mechanization of coal mines has been brought about through the necessity of conditions which were not always mining but frequently were economic conditions. This trend has brought the development of mechanical cutters, loaders, shuttle cars, continuous mining machines, extensible belts, etc. In all cases stress has been placed on developing the efficiency in the working face. True, mine car haulage is a basic problem that has received much thought and development, but it is also one of the man-made conditions with which many coal mines are confronted and one that many have not solved.

An operating mine can continue to show improvements in sectional efficiency but a step toward improving haulage is a broad one. A coal operator hesitates to entertain the thought of replacing all rails, mine cars and locomotives in an individual operation, especially a mine that has been operating for 10, 15 or 20 years. In a mine of this kind the proper approach might be the installation of belt conveyors as an intermediate transportation to mine cars.

Haulage Problems of Contour Mining

Truax-Traer Coal Company's West Virginia operations were faced with that type of problem. For many years the firm has used a mine car that holds 1½ to 2 shuttle cars of coal. It is of moderate height and in certain portions of the property where the mines are now developing it is necessary to brush haulage entries. This fact, coupled with advancing labor costs, made the installation of belts a necessity. This allows the company to mine additional areas with existing haulage equipment, prolonging the useful life of that equipment.

Contour type mines are rather difficult to approach from the standpoint

(Continued on page 74)

View shows the location of Mine No. 7 headhouse (first up the hill) and Mine No. 8 headhouse (second) in relation to the raw coal tipple. Both operations are drift mines having an interval of approximately 300 ft with projections columnarized

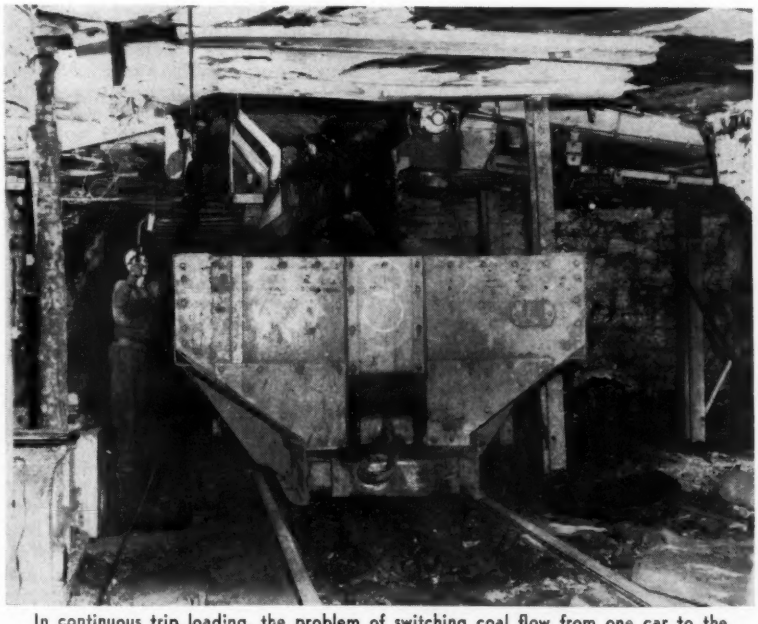
and Mine Car Haulage

A Slope Operation

By C. W. PADGETT
General Superintendent
Bell & Zoller Coal Co.

THE Buckhorn Mine of Bell & Zoller Coal Co. is operated in the No. 6 coal seam, about 3½ miles east of Johnston City, Ill. Coal averages 8½ ft in thickness and is overlaid with a stratum of shale 22 ft thick, which is bolted as the mining advances to provide good roof. Overburden consists mainly of strata of shale, limestone, sandstone and several thin coal beds, and averages 274 ft in thickness. The fire clay bottom, when dry, provides good roadways for shuttle cars and main haulage motors. Faults with vertical displacements ranging from 1 to 60 ft and with a general trend from northwest to southeast are encountered in mining.

In recent years with the advent of continuous mining machines and because of the nearly complete extraction of the coal seam, track haulage has given way to belt haulage in panels at Buckhorn Mine. In the near future, management is planning a new slope operation underground which will combine main line belt haulage with present main line track haulage.



In continuous trip loading, the problem of switching coal flow from one car to the next is met at Buckhorn with a short reversible conveyor mounted transversely under the head of the main belt

In projecting the mining plan, it was decided to develop the workings in an easterly direction off the main bottom, leaving an area in a westerly direction to be developed at a later date. By adopting this plan, it is believed that better concentration of mining activities can be maintained and a more efficient haulage system employed. It seems reasonable to observe that when selecting the most economical transportation system, the final choice can be made only after intensive study of the individual characteristics of the particular property in question.

Maintaining low costs in handling the coal in the most efficient manner is of great importance; likewise, the transportation of men to the working faces as quickly as possible is also of major importance. In Buckhorn's case it is necessary to transport men three miles plus to the active working faces. To transport men and materials this distance, it becomes necessary to have an adequate track haulage system. At Buckhorn the utilization of both track and belt haulage has proved itself applicable to handling of coal and materials, as well as the transportation of men to and from their working faces.

Long Radius Curves and Good Road Beds for Fast Haulage

At the present time Buckhorn is operating both conventional and continuous mining units. Coal is hauled from the mining units to panel belts and discharged from the belt panels into mine cars. It is then hauled to the slope bottom, pulled by 22-ton electric powered locomotives. There it is discharged into a 2000-ton surge bin and conveyed 1480 ft on a 15°30′ slope to the preparation plant.

Continuous haulage is one of the main factors in low cost operation. Realizing the necessity of fast haulage, it is important that long radius curves be laid out and good road beds be maintained so as to not hinder fast moving trips with costly derailments. Buckhorn Mine has 22-ton electric powered locomotives equipped with the latest types of braking devices and with radio communication. Coal is hauled in ten-ton steel drop bottom cars in trips of eight, from the belt loads heads to the main bottom. All main line tracks are 80-lb steel, laid on pressure treated ties. All of the main line rail haulage is double tracked with two exceptions and these areas have electrical signal lights and electrical switches to safeguard transportation.

Men and Material Handling

Unlike many all-belt mines where men and material are transported on rubber-tired equipment, Buckhorn's track and belt haulage provides especially designed personnel cars for the

(Continued on page 76)

CONTOUR TYPE MINES

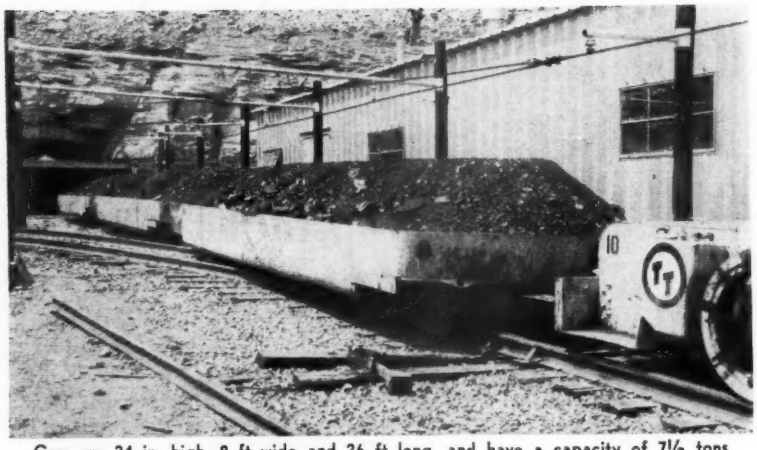
(Continued from page 72)

of haulage. The company has found that it often lays miles of track and recovers only a small portion of coal for its dead work as compared with that which is recovered in shaft and slope mines. In these mines belt conveyors have proven most efficient and profitable in mining small islands, points, etc. Installing an all-belt system in contour mining would result in several miles of conveyor stretched out along the mountain sides and in some cases most unusual operating conditions.

The experience that Truax-Traer has had using a moderate capacity car indicates that management should strive for more tons per foot of car length. The higher the capacity the shorter the trains and the shorter the side tracks required for efficient haulage. Modern cars have better roadability and lend themselves to high-speed haulage and reduce spillage. The problem is to obtain a car for thin seams and still have good capacity and a better live-load to dead-load ratio.

Method of Attack

As far as operations in Truax-Traer's West Virginia Division are concerned, the accompanying graph indicates the method of attack on the haulage problem. Note that this graph indicates the percentage of the division's production that has been assisted by belt haulage starting with 1952. In that year 17 percent of the coal was handled by belts during the production cycle. There has been a steady increase and in 1958 55 percent of the coal is assisted by belts in its production cycle.



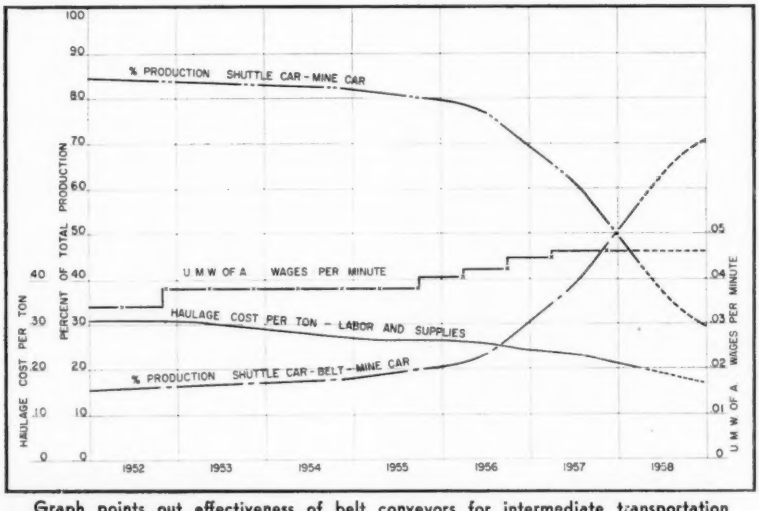
Cars are 24 in. high, 8 ft wide and 26 ft long, and have a capacity of 7½ tons of clean coal

Results of using belts in this fashion are pointed out by the reduction of haulage costs. In 1952 haulage costs were 31 cents per ton for labor and supplies. Since that time there has been a steady decrease to 20c per ton early this year. Plotted also is the United Mine Workers of America's wages per minute. You will note that better than a one-third savings in haulage has been effected in spite of five wage increases amounting to $5.90 per 8 hour day as well as an additional $80 for vacation pay and an additional 10 cents per ton for the Welfare Fund.

These improvements on the division's property as well as on many other operating properties have not been brought about so much by mining conditions but rather through economic conditions—the continual fight for more tons per manshift to keep abreast with rising labor and supply costs.

With the experience gained in older mines concerning haulage as well as mine efficiency, Truax-Traer tried to incorporate the best features when it opened Mines No. 7 and 8 at Eunice, W. Va. These two mines are located on the east side of Marsh Fork of Coal River in Raleigh County. They are both drift mines having an interval of approximately 300 ft with projections columnarized.

Mining plan calls for high capacity loading shuttle car-belt-mine car haulage system. The plan provides for the development of main entries utilizing belt haulage discharging into mine cars at a common point with the belt from room entries. In the panel system butt entries are driven on 800-ft centers, main headings on 60-ft centers 16 ft wide, panel headings on 50-ft centers 20 ft wide and all breakthroughs, on 80-ft centers with the exception of ventilating barrier blocks in the mains. They are driven 160 ft at times. Rooms are driven on 40-ft centers 26 ft wide. The plan of ventilation incorporates the bleeder system and provides that each operating section is ventilated on a separate split of air. Roof control is accomplished by means of roof bolting supplemented by straight posts.



Graph points out effectiveness of belt conveyors for intermediate transportation to mine cars at Truax-Traer Coal Company's West Virginia operations. Note that haulage costs have dropped from 31 cents per ton for labor and supplies in 1952 to 20 cents per ton in early 1958

Sequence of Flow of Coal

No. 8 Mine is operating in the Powellton Seam and underneath it No. 7 Mine is operating in the Eagle Seam. All coal, with the exception of one section at No. 8 Mine, is loaded with Goodman 965 loading machines. These loaders are equipped with two 20-hp head motors, hydraulic controlled, and have an operating height of 26 in. Preparation in No. 7 Mine is done by means of 11 RU cutting machines equipped with dual wheels and a bug-

Switch controls water spray for belt

duster. Each machine has a Jeffrey A-9 hydraulic drill mounted on it. No. 8 Mine has two 12 RB cutting machines equipped with bugdusters and hydraulic hand-held drills also. Each conventional section is equipped with three shuttle cars to take the production from the loading machine. No. 7 Mine is equipped with Joy 6 SC shuttle cars and No. 8 Mine has Goodman 870 shuttle cars. Each section is equipped with a Fletcher DAE-7-28 roof bolt machine.

No. 8 Mine has one operating section that utilizes a Jeffrey 76 AM Colmol, a 12 BU loading machine, a Long Piggyback and self-tramming chain heads to improve and assist in moving the sections. This unit also includes a Fletcher roof bolting machine and a utility truck called a pan transporter — manufactured by the Long Co. — which enables the crew to handle five to 6 pans at a time.

Haulage from the tail piece to the mine cars utilizes Goodman 30-in. rope belts. The three shuttle cars on each conventional section discharge on the tail piece or along the belt conveyor. Each mine is equipped with three of these conveyors each of which has enough structure and rubber for 1800 ft. The Mains are developed using belts and this coal is conveyed to the loading point across the track entry by means of a 15-in. Long chain conveyor. At present there are two automatic loading stations on hand that were manufactured by Stamler. The company expects to install them in the near future and plans to add two more to each mine, placing both mines on an automatic loading point setup.

The mine cars manufactured by Differential Steel Car Co. are moved under the boom by means of a Nolan Car Spotter. These cars are 24 in. high, 8 ft wide and 26 ft long, and they have a capacity of 7½ tons of clean coal. The rotary dump is operated by the trip rider, and the headhouse has a storage capacity of 175 tons of coal.

The rope belts used are advanced in increments of 240 ft. Water for sprays and fire protection is available from a 10,000-gal tank on the surface. Other safety devices include slippage and interlocking controls. Belt conveyors installed in both mines have a speed of 425 fpm.

"Home Made" Ballast Car

Mine cars are moved to the headhouse by means of two 13-ton tandemized locomotives that were built in the company's shop. These locomotives are equipped with hydraulic brakes, sanding and dynamic brakes. Trips are operated with a locomotive on either end and while one motorman is making arrangements to switch his locomotive, the other is dumping one car at a time. The mainline haulage entry is brushed so as to maintain a minimum of 48 in. above the top of the rail. Construction of the haulage roads consists of creosote treated ties, 70-lb rail, No. 4 turnouts and crushed limestone for track ballast. The ballast car, which was developed by company personnel, is a mine car to which has been added a chain with flights similar to those in a shuttle car. The use of this ballast car facilitates the distribution of the limestone. Tamping of the ballast is accomplished by use of pneumatic tools.

A typical sectional crew utilizing the three shuttle cars consists of:

Cutting Machine	**2 Men**
Loading Machine	**2 Men**
Shuttle Cars	**3 Men**
Roof Bolter	**1 Man**
Boom Man	**1 Man**
Belt Man	**1 Man**
Foreman	**1 Man**
TOTAL	**11 Men**

Conclusion

Combination belt and mine car haulage facilitates the extension of haulage during rapid development and extraction behind high-capacity equipment. Belts also permit the mining of a considerable area, the tonnage of which is dumped at a single point, reducing the number of loading points and side tracks necessary for efficient mine car service. These loading points also provide a more uniform loading of mine cars, giving the coal operator the fullest efficiency of his equipment.

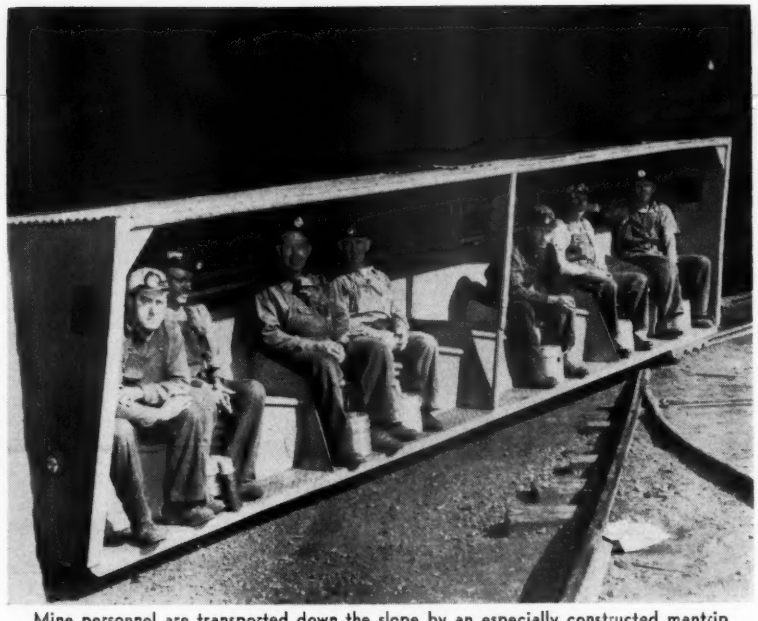
The operating condition of these two mines was anticipated to the degree that Truax-Traer was able to incorporate methods which had been developed at its older mines of employing intermediate belt haulage. Under the conditions the two mines have, the use of a combination belt and mine car haulage system has proven successful.

The ballast car—a mine car to which has been added a chain with flights—facilitates the distribution of limestone. Ballast is tamped pneumatically

(Continued from page 73)

transportation of men to the working faces. Mine personnel are transported down the slope by an especially constructed mantrip car, having a capacity to carry 40 men. This car is equipped with magnetic track brakes which can be activated by a built-in over-speed device or by a manual control that can be activated by pulling a cord that runs the entire length of the car. At the bottom landing the men transfer to underground mantrip cars of steel construction with an insulated top.

The handling of supplies is all done on the third shift, but material cars are loaded on the surface prior to this shift. Once down the slope, these flat bed, stake-sided material cars are directed inside to their proper destination by the third shift foreman. Supplies are then transferred into especially made battery-powered supply jeeps or into converted battery-powered shuttle cars. By this means, supplies are then taken to specific locations in the working territory.



Mine personnel are transported down the slope by an especially constructed mantrip car equipped with magnetic track brakes

Belt Haulage in Panels

Buckhorn, as well as some of the other Bell & Zoller mines, has employed belt haulage in panels, mainly because of the over-all efficiency and operating economies. The use of belts within panels lends itself to a higher degree of concentration and a higher unit productivity as well as freedom from car changeouts and derailments over lightweight rails within the panel. Plans in the immediate future call for the installation of 36-in. rope-type belts, although at the present time, all panel belts are 30-in. wide and have 50 hp drives with a speed of 500 fpm.

In continuous trip loading, the problem of switching coal flow from one car to the next is met at Buckhorn with a short reversible conveyor mounted transversely under the head of the main belt. This permits the cars to be loaded in a uniform manner without spillage or stopping of the belt. Cars are moved in under the belt head against a one percent grade by an electrically operated rope hoist.

Coal is transferred from shuttle cars to the conveyor belts by two different methods:

1. **By discharging coal onto an elevating conveyor set at right angles to the belt line.**
2. **By discharging coal into a hopper set at the end of the belt line.**

In order to keep production units going at full capacity, it is necessary to have shuttle cars discharge their load as fast as possible. Realizing the fact that two or more shuttle cars would be dumping onto the belt at the same time, something had to be done in order to eliminate a costly delay on shuttle car wait and yet give an even distribution of coal feeding onto the belt at all times. In order to overcome these problems, management decided to use elevating conveyors with a capacity that would let the shuttle car discharge its entire load in 45 seconds. The elevating conveyor will discharge its load at the rate of three tpm while the shuttle car is on its return to the machine. At the end dump, there are chutes so designed as to let shuttle cars discharge rapidly and feed the coal uniformly on the belt.

This method of belt loading also contributes to longer belt life since each elevating conveyor is equipped with a balanced angle chute to minimize the distance of drop as well as to turn the coal in the direction of belt travel. Spillage that ordinarily results from a 90 degree transfer from shuttle car to belt is virtually eliminated by this method of loading.

In conclusion, management feels that the combination of belt and track haulage at Buckhorn Mine has been highly satisfactory. The arguments pro and con—belt haulage, or track haulage, or a combination of both—can only be answered after an intensive study of the characteristics of the particular property in question.

Coal is fed out of the 2000-ton surge bin onto a belt and conveyed 1480 ft on a 15° 30′ slope to the preparation plant

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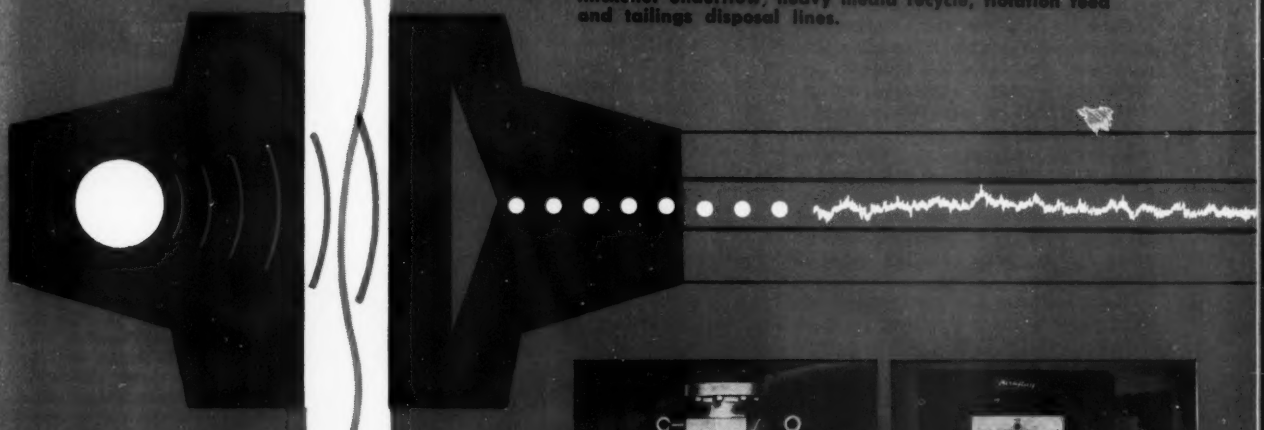

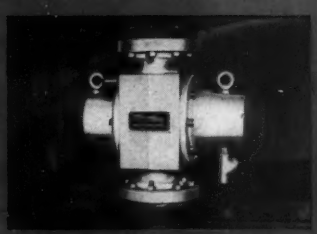

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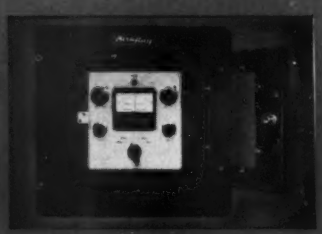

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Operators' Corner

Service Station on Wheels*

SERVICING of large heavy duty equipment such as shovels, drills, portable compressors and truck units in open pit operations has always been a problem because numerous grades of oil, fuel and grease are needed by the various types of equipment.

The open pit mining department, Nevada Mines Division, Kennecott Copper Corp., has recently overcome this problem by constructing a specially designed lubrication service truck. Sam Saunders, veteran pit garage foreman, originated the idea and supervised the construction. A 2½-ton, 1950 truck chassis with four-wheel drive that was formerly in use as a water truck was utilized.

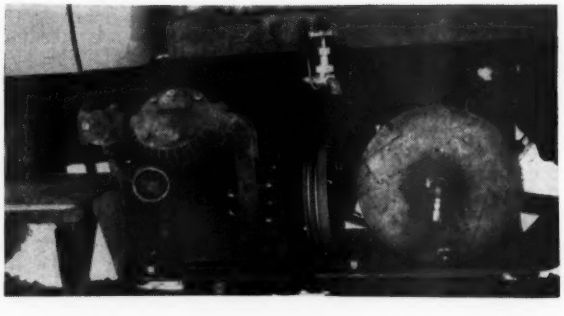
Capacity and features of the new lubrication service truck include a 500-gal diesel fuel oil tank mounted directly to the rear of the cab, and another tank that has four compartments of 60 gal each for engine oil, hydraulic oil, gear oil and gasoline. The gasoline compartment is also utilized as a fuel tank for the truck. To the rear of the second tank, a rack is provided to hold a 400-lb drum of chassis grease, along with smaller cans of special grease.

The truck also has a two-stage air compressor which will deliver 18 cu ft of free air at 100 lb pressure to a storage tank each minute. Mounted under the left side of the diesel fuel tank, the compressor is driven by a power take-off. The air receiver, made at the Veteran shops, is 18 in. wide by 24 in. long, with about 22 cu ft capacity. The air compressor has many uses around the pit equipment, such as checking tires, building up compression tanks for starting of diesel truck motors, cleaning out fuel lines and blowing out radiators.

Hose reels for the chassis grease, lubricant and hydraulic oil hoses are mounted under the right side of the diesel fuel tank. In addition, two hose reels for the fuel and compressed air hoses are located at the rear of the truck.

Primary purpose of this unit is to provide complete service facilities on one truck that will negotiate rough terrain in reaching equipment that might otherwise have to be brought to the service facilities. The service truck is proving to be a very valuable aid in reducing maintenance time.

A combination lubrication and fuel truck, the unit provides complete service facilities for pit mining equipment. Note hose reels for the chassis grease, lubricant and hydraulic oil hoses



Compressed air has many uses in the field, mainly for blowing out air filters and inflating tires, but is especially valuable where equipment with air starters is being used

Two hose reels for the fuel and compressed air hoses are located at the rear of the vehicle. This service truck is proving to be a valuable aid in reducing maintenance time

* Based on an article in *Kennevadan*, March 1958.

As Viewed by HARRY L. MOFFETT of the American Mining Congress

Among the major problems facing the 86th Congress when it convenes next January 7 will be the huge Federal budget deficit piling up during the current fiscal year. According to the Administration's latest estimate, Uncle Sam will run $12.2 billion in the red by the year's end June 30, 1959, compared with a $500 million surplus predicted in January.

The unfavorable shift is due to a lower estimate for receipts and higher estimates of expenditures, but Budget Director Stans noted that the deficit would be reduced "if the improvement in economic conditions exceeds present assumptions." On the other hand, Government outlays could climb if there is little or no abatement of current international tensions.

Acting under the authority of a law approved in the closing days of the 85th Congress, the Interior Department has established a new Office of Minerals Exploration. OME will carry on the program of the defunct Defense Minerals Exploration Administration, assuming responsibility for DMEA contracts still in force and for each project already certified by DMEA as a discovery or development. The Department has issued tentative regulations under which 33 minerals are eligible for financial assistance—the same as under DMEA except for the omission of tungsten.

LEAD-ZINC TARIFF ACTION ASKED

Taking the only course of action open after the House of Representatives rejected the minerals stabilization bill in the closing days of the 85th Congress, the Emergency Lead-Zinc Committee has appealed to President Eisenhower for immediate action in implementing tariff relief "to preclude the further loss of this vital domestic natural resource industry."

In a telegram to the President, Committee Chairman C. E. Schwab pointed out that on June 19 the President had suspended final action on the pending lead-zinc escape-clause case until Congress considered the so-called Seaton minerals stabilization plan. House rejection of this plan, the telegram stated, "now places the most critical and distressing problem of the domestic lead-zinc mining industry again before you for a solution."

In this escape-clause case, the Tariff Commission on April 24 unanimously found that the industry was being injured by imports, but split down the middle in the amount and type of relief recommended. Three Commissioners recommended increases to the the maximum possible rates under the Trade Agreements Act of 1955 together with quotas on imports, while the other three recommended lesser rate increases without imposition of quotas. Schwab's telegram urged the President to act in accordance with his authority under the Trade Agreements Act of 1958, under which it is believed the President could, if he so decided, raise rates of duty to far higher levels than recommended by the Commission.

The President has received similar requests from members of Congress, and the White House said in reply to Rep. Ed Edmondson (Dem., Okla.) that final action on the Tariff Commission report is now "appropriate" and that the "many issues involved are now being carefully considered in the light of recent developments."

Meanwhile, representatives of nearly 40 Nations, including the United States, held a week-long meeting in London to discuss the need for intergovernmental stabilization of production and shipments of copper, lead and zinc.

The meeting, held under United Nations auspices, issued a statement with respect to copper that "no action was required at this time inasmuch as the copper situation was improving," but noted that "if at any time difficulties should arise, there was no procedural obstacle to the holding of a further meeting."

As to lead and zinc, the conference decided to seek the nations' views on suggested temporary restrictions on exports and world production. The conferees issued no statement as to how such proposals would be implemented by the nations and producers involved.

STOCKPILING CUT TO FOUR ITEMS

Only four materials will be purchased for the national stockpile during fiscal year 1959, according to a recent announcement of the Office of Civil and Defense Mobilization. The items are amosite asbestos, small diamond dies, muscovite block mica and film mica.

OCDM officials said that other commodities could be added to the list later. The reduction of goals was brought about by (1) the filling of many of them during the past year and (2) the change in expectancy of the duration of a future all-out emergency from a five- to a three-year period. The materials may be acquired through market purchases, barter, or by transfer from stocks of other Government agencies. During the past year, the Government purchased lead, zinc, aluminum, manganese, metallurgical-grade fluorspar and electrolytic chromium metal in addition to the four minerals still being acquired. It is estimated that a carry-over of $70 million from last fiscal year will be available for the purchase of the four commodities.

Also, OCDM announced plans for the upgrading of oxygen-free copper, ferromolybdenum, ferrovanadium, molybdic oxide and tungsten-carbide

Washington Highlights

LEAD-ZINC: Tariff Action requested.
STOCKPILING: Reduced to four commodities.
OIL IMPORTS: Quota system revised.
URANIUM: Reserves seen adequate.
WILDERNESS: State hearings scheduled.
PENSION BILL: Signed.

power. The upgrading will be done by private businesses on a bid basis; a $3 million appropriation is available for the purpose.

OIL IMPORT QUOTA SYSTEM REVISED

A new system of allocating quotas for crude oil and unfinished oil imports has been proposed by Captain Matthew V. Carson, Jr., Administrator of the Voluntary Oil Import Program.

Under the new proposal, quotas will be based on domestic refinery runs, with the over-all level of imports computed on the basis of total demand rather than domestic production. In the past, import quotas have been based on historical importing patterns. The Bureau of Mines has estimated that the proposed over-all level of imports would be 10.1 percent of annual total demand, roughly equivalent to the total imports now permitted. The quota allocated to a domestic refiner could not be transferred or assigned, according to Carson.

Quotas have been frozen until January 1, 1959, and the new proposal intends to make a gradual change-over from the present quotas to the new quotas by the end of 1959. It was also indicated that a new system of import quotas may be established for the West Coast as well as the rest of the Nation, with somewhat higher quotas for the West Coast refineries than the rest of the country.

The new proposal makes no mention of imports of residual oil.

URANIUM RESERVES SEEN ADEQUATE

Jesse C. Johnson, director of the Raw Materials Division of the Atomic Energy Commission, recently told those attending the United Nations' Second International Conference on the Peaceful Uses of Atomic Energy that reserves of uranium in the Free World are plentiful for the foreseeable nuclear power program, with reserves in areas under development amounting to 1.5 million tons of uranium oxide with ultimate production of 2 million tons.

Johnson's estimates were based on $10 per pound on uranium and less on oxides, and excluded uraniferous shale and phosphate deposits. Canada and South Africa, according to Johnson, indicate about 400,000 tons of uranium oxide reserves; the United States about 220,000 tons, and France up to 100,000 tons. Also included are reserves elsewhere. He said the U. S. will soon lead Free World output with 1958 production of 15,000 tons annually and expected production by 1960 of 20,000 tons. Canada's production is 13,000 tons and will reach 15,500 tons by 1959. France's production rate is 500 tons and is expected to increase to 1500 tons by 1962. South African production is more than 6000 tons.

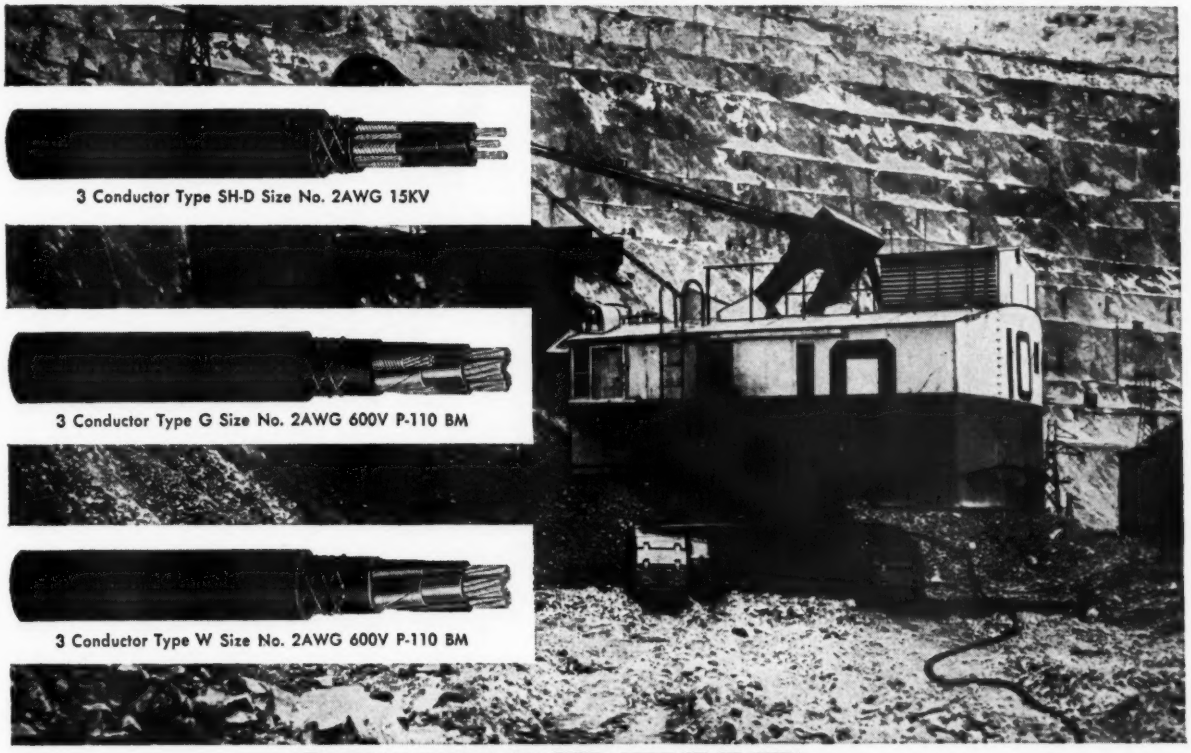
Johnson said, "On the basis of current production costs, a price of from $8 to $10 per pound of uranium oxide in a mill concentrate should support substantial production—a production rate in excess of 40,000 tons of oxide per year. The United States anticipates that the domestic price of $8, which has been established for the period March 31, 1962 through 1966, will provide most of its producers with a profitable market. Many of the mills in the U. S. A. will have been fully amortized by 1962, and this will influence the profit margin considerably. . . . If there is a major expansion in total requirements, to something in excess of 40,000 tons of oxide a year, the price for uranium may increase because of the need to encourage exploration and development and the construction of new plants."

Johnson anticipated an expanded uranium market by 1965 and said, "Fortunately for the initial development of atomic power, nuclear fuel for some time

(*Continued on page 90*)

GENERAL CABLE SUPER SERVICE

PORTABLE POWER and MINING CABLE



with SUPERTUF Jacket

GENERAL CABLE offers a complete line of SUPER SERVICE portable power and mining cables which will stand up under the most severe operating conditions and furnish longer life and reliable service no matter how difficult the application.

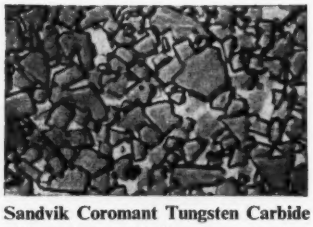
All SUPER SERVICE cables are jacketed with an extra heavy duty, vulcanized in mold, double layer cord reinforced "SUPERTUF" neoprene sheath with maximum resistance to tearing, cutting, abrasion and overall mechanical abuse, and possessing outstanding resistance to water, oil, acids, alkalis, flame and effects of sunlight and weathering.

SUPERTUF neoprene jacket far exceeds the requirements of ASTM D-752, and all 600 volt SUPER SERVICE portable cables bear the official approval number P-110 BM embossed in the jacket indicating compliance with the flame resistance requirements of the Pennsylvania Department of Mines and requirements of the Federal Bureau of Mines.

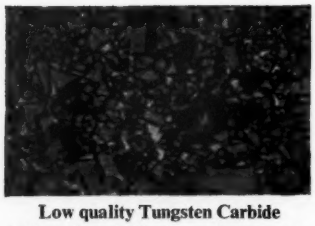
GENERAL CABLE CORPORATION, 420 Lexington Avenue, New York 17, New York
Offices and Distribution Centers Coast-to-Coast

for quality and service . . . **specify GENERAL CABLE**

Longer bit life— with *new* Sandvik Coromant Bits



Sandvik Coromant Tungsten Carbide (Microphoto) Uniformity of size, even distribution of grain are marked. Free from porosity and impurities —therefore stronger, longer-lived.



Low quality Tungsten Carbide (Microphoto) Black marks are contaminations caused by deficient production control. They weaken the carbide, reduce its working life.

Sandvik Coromant Detachable Bits are Available in the following Thread Sizes and Bit Diameters

Type	Thread	Available Diameters, in Inches														
		1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2¾	3	3½	4	4½	5
SHOULDER	F	x	x														
	113	x															
	H		x	x	x	x											
	115		x	x													
	D					x	x	x	x	x	x	x	x				
	K												x	x	x	x	
BOTTOM	1" Rope			x	x	x											
	200			x	x	x											
	1¼" Rope					x	x	x	x		x		x				
	400						x		x		x						
	1½" Rope										x	x	x	x	x		
	600										x	x	x	x			
	700												x	x			
	J. 7.5														x	x	
	2" Rope													x	x	x	x

NEXT time you buy bits, specify Sandvik Coromant because they give more footage per bit, lower drilling costs. Here's why:

1 Only first-quality tungsten carbide is used —as shown in the microphotos above. This means less wear, longer life and a better job.

2 The bodies are precision-made of high quality alloy steel—tough enough to take the strain throughout the extra-long bit life.

3 The bigger Sandvik Coromant bits are all of X-design, which prevents rifling. No wonder Sandvik Coromant inserts are the most widely used in the world, drilling more than one billion feet every year.

SANDVIK COROMANT bits are supplied through Atlas Copco, the world's largest manufacturer of rock drills, who also supply Sandvik Coromant integral steels — the most widely used in the world — and Sandvik Coromant extension steel equipment.

Write or phone today for further details to either of the addresses below:

610 Industrial Avenue
Paramus, New Jersey
COlfax 1-6800

Atlas Copco

930 Brittan Avenue
San Carlos, California
LYtell 1-0375

personals

United States Borax & Chemical Corp. has announced the appointment of **P. J. O'Brien** as vice president, Production and Engineering, and the appointment of **R. F. Steel** as vice president, Finance and Administration. The new positions held by O'Brien and Steel were created to divide the heavy managerial responsibilities formerly centered in one office.

Steel, who was recently promoted from secretary and treasurer to assistant general manager, has been with the company for 12 years. O'Brien, who joined the United States Potash Company in Carlsbad, N. M., in 1933 and later transferred to Pacific Coast Borax Co. had served as general manager of the United States Borax & Chemical Corp. since its formation in 1956, when the Pacific Coast Borax Co. merged with the United States Potash Co.

John L. Schroder, Jr., has been appointed general superintendent, Lynch District, United States Steel Corporation's Coal Division. He succeeds **T. E. Johnson** who was named special representative, southern district of the Coal Division.

Schroder joined the H. C. Frick Coke Co., a division of U. S. Steel, in 1941 as a junior engineer. From

J. L. Schroder

T. E. Johnson

1944 to 1946, he served in the United States Navy. Upon separation from the service, he was employed by the Gay Mining Co. as production and safety engineer. In 1949 Schroder returned to U. S. Steel as assistant engineer—mine planning in the Gary, W. Va., district of the Coal Division. He successively became assistant chief engineer, chief engineer and, earlier this year, was appointed acting general superintendent, Lynch district.

Johnson joined U. S. Steel at Lynch in 1919 after serving two years with the U. S. Naval Reserve Force. During his 39 years with the corporation, he was employed as chainman, transitman, mine inspector, superintendent, acting assistant general superintendent and assistant superintendent of the Lynch district. In 1951, he was named district superintendent and in 1956, was appointed general superintendent of the Lynch district.

Universal Atlas Cement Division, U. S. Steel Corp., has made several recent appointments in its New York office.

W. Owen Lawrence, assistant vice president—operating, is appointed to the newly created position of assistant vice president — engineering and research. **J. Palmer Camm,** plant manager, Independence, Kans., is appointed general manager—operating. **Roald W. Nygaard,** plant manager, Duluth, Minn., is appointed assistant general manager—operating. **Chester D. Rugen,** assistant vice president—engineering, New York, is appointed assistant to vice president—manufacturing. **F. P. Diener,** director—tests and research, is appointed director—research. **Arthur Horen,** director—raw materials, who has been principally concerned with geological investigations, is appointed assistant director—research.

Frank A. Burns has been appointed superintendent of the Crucible Steel Company of America's coal mine in Crucible, Pa. He succeeds **A. V. Faull** who was transferred to the recently-acquired Hugheston Mine in West Virginia.

Burns has been connected with the coal mining industry since 1948 when he worked as an engineer in training and later as assistant to the superintendent with the Bethlehem Mines Corp. Coming to Crucible in 1953, he served as engineer—mining practices, assistant mine foreman, general assistant mine foreman and acting mine superintendent.

Fred A. Brinker has been named an assistant vice president of Vanadium Corp. of America. Formerly chief metallurgist of the firm's western division, he has been with the company since 1951. Before that he was manager of Highland Mary Mines at Silverton, Colo.

Henry C. Rose, for the past seven years president of the Pittsburgh Coal Co., Division of Consolidation Coal Co., retired August 15 for reasons of health. Rose had been employed in positions of increasing responsibility at Pittsburgh Coal since 1928, shortly after his graduation from Ohio State University.

He was succeeded as president of Pittsburgh Coal by **George O. Tarleton,** vice president of Consolidation and formerly president of the Kentucky Division.

Shenango Furnace Co. has named **Fayette Brown, Jr.** vice president in charge of the mining and lake transportation of iron ore succeeding **A. L. Fairley, Jr.,** resigned. Brown will take his new post October 1 and will make his headquarters in the firm's executive offices in the Oliver Building, Pittsburgh.

F. Brown, Jr.

A graduate of Yale University, Brown has been affiliated with the Cleveland-Cliffs Iron Co., where he most recently served as assistant vice president—mining and research.

Lehigh Valley Industries, Inc., formerly Lehigh Valley Coal Corp., has announced that **Eugene Schoener,** vice president, has been elected executive vice president of the corporation as well as president of Lehigh Valley Coal Sales and Lehigh Valley Coal Co.

It was also announced that **Henry S. Weatherhold,** general manager of Lehigh Valley Coal Co., has been elected vice president of the company.

J. William Stoner retired at the end of July as secretary and treasurer of United Park City Mines Co. and was succeeded by **E. LaMar Osika.**

Stoner came to Park City in 1918 as chief engineer of the Judge Mining & Smelting Co., later organized into the Park Utah Consolidated Mines Co. He was later named secretary of Park Utah and with the merger of Park Utah and Silver King Coalition Mines Co. in 1953 into the newly formed United Park City Mines Co., he became secretary and treasurer.

Osika joined Park Utah in 1935 and was named chief clerk of United Park City when that company was formed.

Otis J. Gibson has been elected secretary of Old Ben Coal Corp. Gibson comes to Old Ben from the Western Pacific Railway where for the past seven years he served as general attorney. Prior to that he was commerce attorney for the Denver & Rio Grande Western Railway Co.

Dr. Schrade F. Radtke has been appointed to head the joint research program currently being initiated by worldwide lead and zinc producers.

According to Simon D. Strauss, vice president American Smelting and Refining Co., and chairman of the joint program's Executive Committee, Ratke has been chosen to manage research projects under the direction of the Industry Development Committees of the American Zinc Institute, Inc. and the Lead Industries Association. An aggressive program is contemplated in hopes of developing appropriate new knowledge and creating potential new products and uses for lead and zinc.

Zenon V. Kosowski has joined the staff of North American Coal Corporation's Research and Development Department as a project engineer. He will be responsible for developing the Udy process for recovery of high grade alumina from low grade ores and coal mine wastes. This project was announced last February as a joint venture between North American Coal and Strategic Materials Corp.

E. H. Lindsey, formerly with the Anaconda Co., is now associated with Wisser & Cox, consulting geologists in San Francisco.

R. F. Wesner has been appointed vice president in charge of operations of Boone County Coal Corp. He will continue as general manager of the company with headquarters at Sharples, W. Va.

The retirement of Admiral **Ben Moreell** as chairman of the Jones & Laughlin Steel Corp. has been announced. He will be succeeded by **Avery C. Adams**, who will continue as president and chief executive officer. The changes are effective October 1.

Dr. Troy L. Pewe has been named head of the Department of Geology at the University of Alaska. Until his appointment, Dr. Pewe served as geologist-in-charge, U. S. Geological Survey—Alaskan Geology Branch. He will continue in the capacity with U. S. Geological Survey during the summer months.

It was recently announced that **Clare E. White** has been named president and chief operating officer of the Ungava Iron Ores Co. Associated in the Ungava development are Cleveland-Cliffs Iron Co., Steep Rock Iron Mines and Premium Iron Ores Ltd., together with a group of German steel companies.

Bethlehem Mines Corp. has named **James F. Wildey** to the newly created position of director of safety and inspection with headquarters at Johnstown, Pa.

Dr. Armine F. Banfield, after serving for eight years as an associate, has been admitted to partnership in the firm of Behre Dolbear & Co., Inc.

James S. Gelston has been promoted to manager of mines for West Penn Power Co. at Pittsburgh, Pa. and vice president of both Allegheny Pittsburgh Coal Co. and Windsor Power House Coal Co., the utility's two coal subsidiaries.

Alan E. Gallie, who has been in charge of the Lynn Lake, Manitoba, nickel-copper mines of Sherritt Gordon Mines, Ltd., for the past 12 years, has been transferred to Toronto as assistant to the president. **J. R. Muter** succeeds Gallie as manager for Sherritt Gordon at Lynn Lake.

O. T. Hansen has been appointed mine inspector for the state of Idaho, succeeding **George McDowell.** Hansen will fill McDowell's unexpired term of office. McDowell recently resigned to take over a sales position with an explosive company.

George P. Lutjen has joined the staff of American Metal Market as assistant to the publisher. Lutjen, who was employed in an editorial position and more recently in advertising sales with McGraw-Hill Publishing Co. has had experience as a practicing mining engineer with the Freeport Sulphur Co., and with the U. S. Atomic Energy Commission.

Ernest Curth has been appointed to the new position of coordinator of research for the West Virginia State Mines Department. Crawford L. Wilson, state Mines Director, said he created the new position under the revised mining law which authorizes the State Mines Department to carry out research work with special personnel. Curth will work with federal mine inspectors to develop safety measures, then pass these on to state mine inspectors and coal companies by traveling about the state.

Curth formerly was employed by Pocahontas Fuel Co.

John D. MacKenzie has been elected chairman of the board of American Smelting and Refining Co. to fill the vacancy caused by the death of the late **Kenneth C. Brownell.** MacKenzie will continue as president of the company.

J. D. MacKenzie

A native of Pembina County, N. D., MacKenzie joined Asarco in 1920 as a chemist at the company's Garfield, Utah, smelter. He rose through the ranks to become vice president in charge of smelting operations in 1948, and was elected a director in 1949. He became president of the company in April of this year.

— *Obituaries* —

Thomas M. Bains, 81, mining and metallurgical engineer, died August 14 at Napa, Calif.

Following service in the Spanish American War and the Boxer Rebellion, Mr. Bains graduated as a mining and metallurgical engineer from Columbia University in 1911. After graduation he worked in various mines in California, Arizona, New Mexico and old Mexico. Later he was called to serve as associate professor in the Case School of Mining. He served in similar capacities at the University of Minnesota, The Colorado School of Mines, and Oregon State College. In later years he worked on the Pacific Coast as mine examiner for Reconstruction Finance Corp. During World War II he was principal economist in the tin, lead and zinc section of the War Production Board.

James Jamison, 42, a member of a pioneer Pennsylvania coal mining family, drowned in the Allegheny River near Greensburg, Pa., on August 19. The accident occurred as a cabin cruiser upon which Mr. Jamison was a passenger was preparing to dock.

Mr. Jamison's father, the late Charles M. Jamison, and his uncles, the late U. S. Senators, John M. and Richard Jamison, pioneered the opening of Western Pennsylvania's coal fields.

Frank F. Grount, eminent geologist, died in Minneapolis, Minn., August 1 at the age of 78.

In 1948 Mr. Grout retired after rounding out 40 years as professor of geology and mineralogy at the University of Minnesota. For several years he served as director of the Minnesota Geological Survey. Following retirement he taught geology for short periods at the University of Florida, Columbia University, the University of Arizona, and California Institute of Technology.

NEWS and views

Utilities Consumed 160,800,000 Tons of Coal

Coal continues to supply more than twice as much fuel for the nation's steam-electric generating plants as natural gas and oil combined, according to a National Coal Association publication. The eighth annual edition of *Steam-Electric Plant Factors* credits coal with 69 percent, natural gas 23 percent, and oil 8 percent of the total fuel consumption by both private utility and publicly owned generating facilities.

Total electric utility consumption of bituminous coal and anthracite in 1957 amount to 160,800,000 tons—a gain of about 2,500,000 tons over 1956 and an 82 percent increase over 1947. Most of the solid fuel consumption—157,400,000 tons — was bituminous coal. Regionally, coal's biggest gain (9.4 percent) over 1956 was in the South Atlantic area, which includes West Virginia, Delaware, Maryland, District of Columbia, Virginia, Georgia, North and South Carolina, and Florida.

The steam electric study, prepared by NCA's Department of Economics, covers installed capacity, net generation, and fuel consumption costs of 768 plants reporting to the Federal Power Commission, representing 97.4 percent of all fuel-fired generating capacity. It also lists capacity facilities now under construction or scheduled to be built within the next three years.

Inco Provides Financial Aid to Teachers

More than 150 high school teachers from across Canada took advanced studies this summer in special university summer courses aided by International Nickel Co. of Canada. Part of Inco's $2,800,000 five-year educational program, the summer courses are designed to give teachers of scientific subjects the opportunity of taking advanced or supplementary studies. More than 400 teachers have taken part in the 15 courses held to date, with Inco sponsoring grants totalling $73,000. The greater bulk of Inco's financial aid to teachers is given in the form of bursaries to defray expenses while taking special course work at Canadian universities.

Coal Pipeline in Full Operation

Consolidation Coal Co. of Pittsburgh, Pa., has announced that its 108-mile coal pipeline, operating between Georgetown and Eastlake, Ohio, is now in full operation. In a recent 30-day period, the line operated at an average rate of delivery in excess of its designed capacity.

Cleveland Electric Illuminating Co. has contracted with Consol to purchase eighteen million tons of pipeline coal over the next 15 years. This will be utilized by the Illuminating Company's Eastlake, Ohio, power plant.

The recently completed coal pipeline culminates many years of planning. A joint undertaking of Consolidation and the electric utility, the pipeline was conceived almost ten years ago by the coal company's engineers and is the longest solids-transporting pipeline in the world. The pipeline and associated equipment cost approximately $13,500,000 to build. Consolidation is the owner, operating the preparation plant and pipeline and the drying facilities at Eastlake.

Cleveland Electric reports "substantial savings" are being realized by the company through the pipeline method of delivering coal.

Accident Facts

The 1958 edition of "Accident Facts," the National Safety Council's statistical yearbook, is now available. It contains facts and figures on all types of accidents. Several sections are devoted to occupational accidents and provide a comprehensive background for an industrial safety program. Further information on the annual publication and quantity prices may be obtained from the National Safety Council, 425 North Michigan Ave., Chicago 11, Ill.

Huge Coal Mine Opened in Virginia

Clinchfield Coal Company's Moss No. 3 mine in Dickenson County, Va., is now in operation. More than $100,000,000 have been invested in the area by the coal company, Norfolk & Western Railway and Appalachian Power Co. to exploit this mine which is expected to become the largest in the state.

Two parallel seams of coal give the new field an average thickness of 14 ft. On top is an excellent layer of steam coal; the bottom layer is particularly valuable because it is of metallurgical quality.

The coal will be shipped to a preparation plant Clinchfield is building in Russell County. In this electronically equipped facility, coal will not only be cleaned and sized, but different qualities will be chemically analyzed and scientifically blended for a variety of uses. Eventually the preparation plant will be capable of processing about 15,000 tons a day. The mine has a potential annual capacity of 5,000,000 tons.

A substantial proportion of the mine's yield will be diverted to the Appalachian Power Company's new steam plant at Carbo, less than five miles from the preparation plant.

Big Taconite Blast

More than a million tons of crude taconite iron ore was recently broken up in one of the largest mining blasts in history. The explosives—625,000 lb—were placed in 794 holes over a 7.1-acre area. They were detonated in 156 separate blasts 0.017 seconds apart. The ore will be processed at Reserve Mining Company's Silver Bay plant and is expected to last for about a month.

Imperial Coal Supports Research Project

A cooperative research program in rock mechanics has been entered into by the Imperial Coal Corp. of Johnstown, Pa., and the Pennsylvania State

(Continued on next page)

(Continued from previous page)

University. The company is supporting the work by a financial grant and providing underground facilities in which the field work can be carried out. The University has assigned a graduate assistant to the project and is providing laboratory facilities in the Department of Mining.

Investigation will entail a study of roof and floor conditions in the Diamond mine, located near Johnstown, with the objective of minimizing the problems encountered with rock strata overlying and underlying the coal seam being mined. Plans are to measure the extent of the load developed on roof supports in the mining area and to install special instrumentation to determine the success of modifications in the mining plan. Laboratory studies of rock specimens and mine models will be carried out.

ALSO . . .

Titanium Metals Corporation of America has announced introduction of a new titanium sheet capable of withstanding extreme heat and stress met by aircraft flying 2100 mph.

Hanna Coal & Ore Corp. recently announced it had purchased common stock of M. A. Hanna Co. bequeathed to charitable and civic groups, for approximately $21,000,000. Purchases were made from the Hanna Fund, established by the late Leonard C. Hanna, Jr., and from the Cleveland Museum of Art, which received its stock as residuary beneficiary of Mr. Hanna's estate. The stock involved is part of that left by Mr. Hanna, who died last October.

Copperweld Steel Corp. plans to spend $1,325,000 for new facilities at its Glassport, Pa., plant for full-scale production of aluminum-covered steel wire. Copperweld has spent several years in research and development work on its new Alumoweld process which utilizes heat and pressure to weld aluminum to the steel.

(More page 88)

Annual Coal Division Conference

Penn-Sheraton Hotel, Pittsburgh, Pa., Friday, November 14, 1958

THE 1958 Annual Conference of the American Mining Congress Coal Division will be held at the Penn-Sheraton Hotel in Pittsburgh, Pa., November 14. The one-day meeting will convene at 9:30 a. m.

A cordial invitation to attend the conference is extended to those who mine and prepare the Nation's coal and to the manufacturers who supply the necessary tools and equipment. Each of the Coal Division committees will recount the results of studies carried on during the past year. As in the past, the reports will be open to discussion from the floor so that all may have an opportunity to offer comments or suggestions—which will be carefully reviewed by each committee in preparing its final reports.

The various studies to be discussed are based on field experience and the reports will be presented by well qualified men from the coal industry. Studies to be covered are listed below:

Committee on Coal Preparation—R. L. Llewellyn, Eastern Gas & Fuel Associates, chairman—Water Clarification — Media Recovery—Speedy Analysis Procedures—Preparation Plant Start-Up Problems.

Committee on Mine Haulage—A. G. Gossard, Snow Hill Coal Corp., chairman—Conveyor Load Regulation—Future Demands on Haulage Systems.

Committee on Mechanical Haulage—Wm. E. Hess, chairman—Continuous Mining Systems—Dust Control with Continuous Mining.

Committee on Roof Action—J. Allan Brookes, Mather Collieries, chairman—Geological Aspects of Mine Roof Control—Standardized Roof Bolt Pull Testing Procedures—Size Coding of Roof Drill Bits.

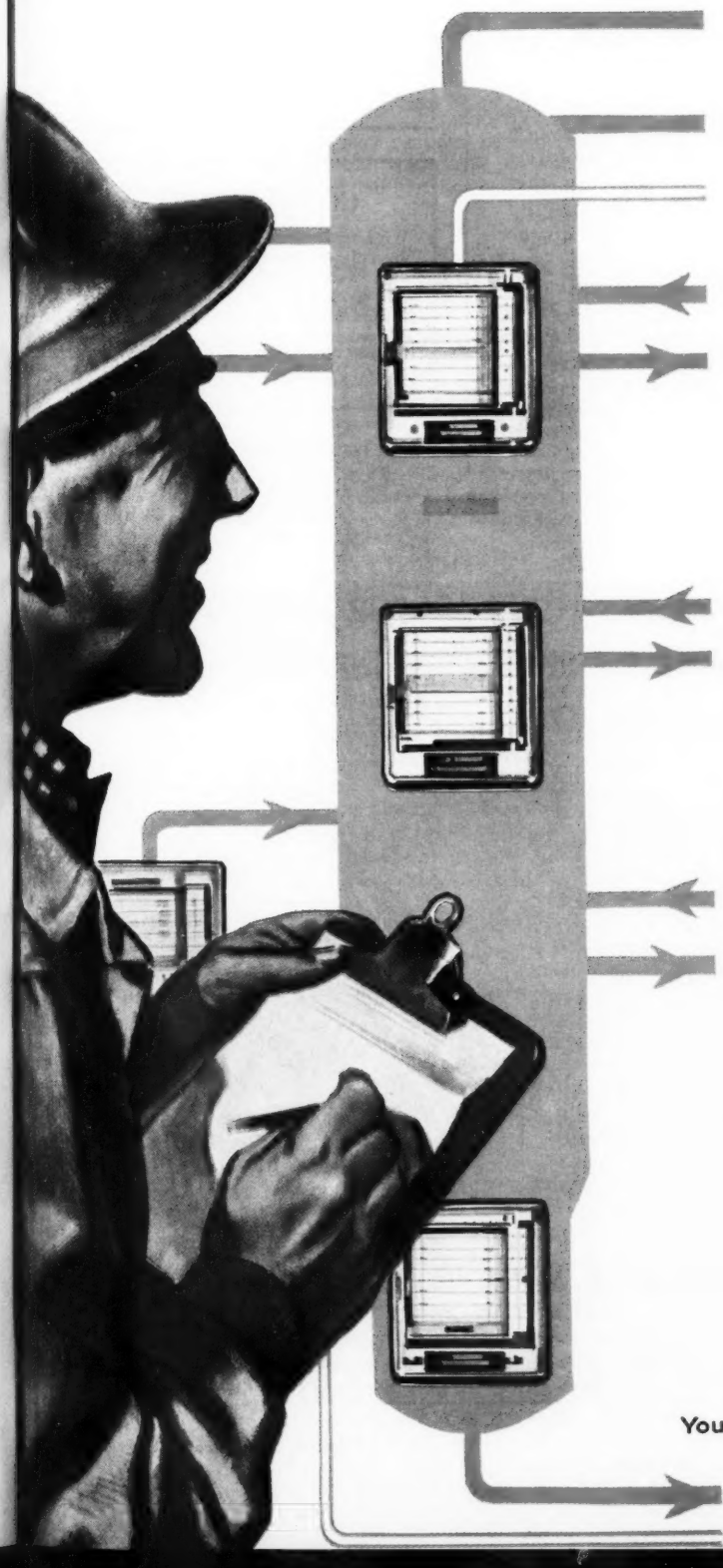
Committee on Underground Power—J. A. Dunn, Island Creek Coal Co., chairman—Temporary Splices—Characteristics of A-C Mining Machinery—Cable and Cable Accessories for A-C Mining—A-C Mine Power Systems.

Committee on Mine Safety—Ralph E. Kirk, Birmingham, Ala., chairman—Improvements in Shuttle Car Design—Recent Advances in Fire Fighting Procedures.

Committee on Strip Mining—E. R. Phelps, Pittsburg & Midway Coal Mining Co., chairman—Dust Control on Haulage Roads—Better Tire Wear—CGAN Blasting—Improving Wire Rope Life.

Nothing gets by

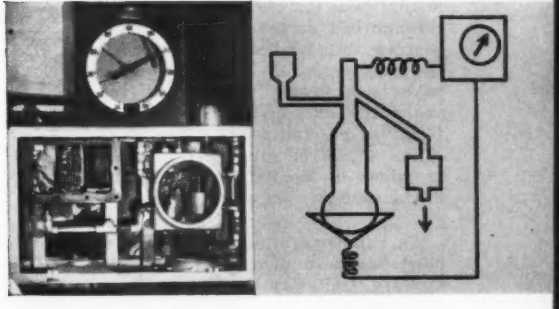
Automatic end-point testing device developed by Standard Oil research men makes certain of the uniform quality of gasoline and diesel fuel delivered to you.



Scientists at Standard Oil never stop in their drive to improve and then improve again the uniform quality of the petroleum products that bear the Standard Oil trade-mark. These engineering research scientists have now created wholly new instruments for performing near continuous physical analysis *automatically*.

One such instrument automatically performs the physical analysis that determines end-point. Using it, refineries maintain a continuous inspection of the temperature at which gasoline and diesel fuels are completely distilled. To you, this means that Standard is able to maintain a constant control over the uniformity and high quality of the gasoline and diesel fuels you use. It also means that Standard Oil power-producing petroleum products, with their constantly controlled end-point, burn uniformly, give you uniform high performance.

This is part of the research pay-out, the "something more" research builds into the products you buy from Standard. This is your return from Standard's investment in research. And now there are 48 district offices in the 15 Midwest and Rocky Mountain states to serve you. Call the one nearest you. **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**



Automatic end-point tester works this way. A small sample is placed in an electrically heated flask. The temperature is measured and recorded during a heating cycle when distillation is accomplished. Distillate is condensed and drained, the flask temperature is lowered by introduction of the next sample, and the apparatus is ready for another test.

You expect more from STANDARD and get it!

1959 Coal Show

PLANS for the 1959 Coal Show of the American Mining Congress, scheduled for Cleveland, Ohio next May 11-14, are moving right along. The Program Committee, headed by E. P. Humphrey, president of Stonega Coke & Coal Co., and Westmoreland Coal Co., is preparing to meet in Pittsburgh next month to undertake the highly important task of selecting topics and speakers for a program that will bring the industry abreast of the latest advances in methods and equipment for mining and preparing coal, and will spark continued progress in mining technology.

Mine operators and manufacturers of mining equipment are invited to send suggestions of topics to be discussed and prospective speakers to the American Mining Congress, Ring Building, Washington 6, D. C. This should be done immediately so that the Committee may have the benefit of the industry's collective thinking in drawing up a program that will throw light on the most important problems in coal mining today.

Equipment manufacturers have already been making plans for next year's big event and many are planning to display new products at that time. All types of equipment, including machinery and supplies designed for use in the many phases of underground and strip mining as well as in preparation plants, maintenance shops and power systems, will be exhibited in what may well be the greatest Coal Show yet.

United States Gypsum Co. has announced plans to build a new gypsum manufacturing plant at Sperry, Iowa, near Burlington. The new plant is expected to be completed by early 1960 and will be the company's fourth gypsum plant in the Midwest.

Kentucky's coal mine operations are said to be well on the way toward establishing the best safety record in history. This was attributed to a vigorous educational program and safety-conscious miners. James H. Phalan, chief of the Kentucky Department of Mines and Minerals, reported 61 miners died in accidents in 1957—the best safety record in the 78-year history of his department. And through last July, the fatality rate is running 11 behind the 34 recorded for the same period in 1957. While there have been fewer fatalities in other years, the 1957 mark is the best for fatalities per ton mined. The report shows 42,678 persons were employed in mines in Kentucky, the majority in the eastern part of the State.

An extensive high-purity silica deposit has been discovered near New Concord, Galloway County, Ky. Preliminary studies which brought out the high quality of the silica and the potential of the deposit prompted the formation of Murray Sand Co. The firm plans to start processing the silica in a $75,000 plant it is building at Murray, Ky., early this fall. Processing the silica will not be new to western Kentucky, but the Murray plant will be the first such operation on a large scale in Kentucky. Corning Glass Co., Corning, N. Y., already has contracted with the Murray firm for 20,000 tons of silica a year.

Oglebay Norton & Co. has been granted a working option and lease by Atlin-Ruffner Mines on its iron property in Montgolfier and Orvilliers townships, Quebec.

"Not merely to sell; but to serve . . . not only to make good steel products; but to make them still better . . . not only to fulfill today's requirements; but to anticipate tomorrow's—these are the principles that constantly guide CF&I."

G. F. Kranz
President

Grinding Mill Bulletin #3

This series of ads on grinding ball rationing of the makeup charge is being presented by CF&I in keeping with our policy "*Not merely to sell; but to serve*". It is our hope that the series will shed some new light on the subject by expressing established principles in practical terms, and that grinding mill operators who are interested in increasing the efficiency and production capacity of their ball mills will find this information of value.

The One-Size Ball Makeup Charge In An Operating Mill

Previous articles in this series have pointed out that determining the optimum size assortment of grinding balls that should be added as a makeup charge is a practical means of improving mill operation; and that the best makeup charge of one-size balls should be established before an attempt is made to work out a rationed makeup charge.

It is better to use oversize rather than undersize balls in the makeup charge. The reason for this is that there is always the possibility of encountering ores that are more difficult to grind. The larger ball would reduce this difficult-to-grind ore, whereas a smaller ball would not. This leaning towards oversize balls is recommended even though they will give fewer contacts and less attrition grinding than a smaller ball.

Indications of Incorrect Ball Size

In a closed circuit mill, a too-small ball size will fail to reduce larger feed particles, and too much tramp oversize will be circulated. Thus, the circuit will become choked, and you will find it necessary to reduce mill feed. With a too-large ball size, coarse particles will be reduced in size, but excessive amounts will need further reduction and excessive slimes may be produced from the impact of large balls. The partially reduced ore particles will overload the classifier, making a reduction in mill feed necessary. Thus both too-small or too-large balls will lower mill production.

In an open circuit mill, balls that are too large do not produce the fineness of grind, or liberation size, required, and they may produce too many slimes. Grinding balls that are too small, on the other hand, permit tramp oversize to enter the next process.

Price May Be Deciding Factor

The 3″ diameter steel ball is commonly the lowest-priced ball available whereas small size grinding balls are priced higher. The 3″ balls are used most frequently in beneficiation mills and are usually obtainable on an immediate-shipment basis. However, where 3½″ and 3″ diameter balls give similar results in grinding a particular ore, the 3½″ ball may be chosen because of the insurance it provides against the production of tramp oversize should more difficult-to-grind feed ore be encountered later. Nevertheless, the lower price of the 3″ ball may be the deciding factor.

Radical Changes are Undesirable

As in other experimental work in an operating circuit, it is good practice not to make too radical a change in the ball size used. Where it is indicated that 4″ diameter balls would be more satisfactory than the 3″ balls in use, it would be wiser to test 3½″ balls first, then check results to prove you are going in the right direction. Or, if it is considered that 2½″ balls will improve results as compared with the use of 3″ balls, it may be better to substitute 2½″ diameter balls for one-quarter or one-half the charge and then check for improvement before using 2½″ balls as 100% of the makeup charge.

Whatever the optimum size grinding ball you need for the makeup charge in your operating mill, you'll find it available from CF&I . . . in diameters from ¾″ to 5″. CF&I grinding balls are forged from special analysis steel and are carefully inspected—throughout production and again immediately prior to shipment—to ensure that they are free of surface pits, circumferential ridges or other surface unevenness. The CF&I representative nearest you will gladly give you complete details.

In the next article in this series, we will discuss general methods of rationing, and the specific steps to be taken in working out a ball ration.

For a reprint of the article on which this ad is based, please write on your company letterhead to: Mining Supply Department, The Colorado Fuel and Iron Corporation, P.O. Box 1920, Denver, Colo.

OTHER CF&I STEEL PRODUCTS FOR THE MINING INDUSTRY

CF&I Grinding Rods · CF&I Grader Blades · CF&I Industrial Screens
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6083

(*Continued from page 80*)

will be available at reasonably low prices. Improvements in the efficiency of power reactors as experience is gained probably will offset or more than compensate for the higher uranium prices that might come with an expanded market."

WILDERNESS BILL HEARINGS SET

Chairman Murray (Dem., Mont.) of the Senate Interior Committee has announced that public hearings will be held later this year in four Western States on a bill to establish a National Wilderness Preservation System on U. S. public lands. The schedule is as follows: Bend, Oreg., November 7; San Francisco, November 10; Salt Lake City, November 12; and Albuquerque, N. M., November 14.

The measure would virtually bar prospecting and mining within the many national forest areas which would be included in the System, and generally limit use of such lands to a relatively few wilderness enthusiasts. The American Mining Congress has stoutly opposed legislation of this type on the grounds that "Any measure which would deter further mineral development through the curbing of the ardor of the prospector would result in a great disservice not only to the Western States but to the Nation as a whole." AMC views have been presented to both the Senate and House Interior Committees.

PENSION REPORTING BILL SIGNED

The President has signed a bill requiring the public disclosure of welfare and pension plans whether administered by unions, by management, or jointly. Plans covering 25 or fewer persons are exempted from the disclosure requirements.

Effective January 1, managers of plans must furnish participants information as to the sources of all money, amount of benefits paid, number of workers covered, assets and liabilities, and salaries, fees and commissions charged to the plan. The reports, which also must be filed with the Secretary of Labor, are required to show how funds are invested and financial dealings with insurance companies. The Secretary of Labor has no power to regulate or supervise the operations of the plans.

NEWS and views

Gilsonite Operation Completes First Year

The world's first privately financed commercial plant to make gasoline and high-purity metallurgical coke from a raw material other than crude oil has completed its first year of operation with all processing phases proved out successfully. The $16,000,000 refinery of American Gilsonite Co., affiliate of Barber Oil Corp. and Standard Oil Company of California, went onstream August 1957 at Gilsonite, Colo.

The raw material, a solid hydrocarbon called "Gilsonite," is mined by hydraulic methods in Uintah Basin of Utah. It is transported to the refinery 72 miles away by a six-in. pipeline which attains a maximum elevation of 8500 ft in traversing the Book Cliffs Mountains.

All phases of the project are operating successfully in excess of designed rates, company officials report. When the refinery first went into operation 12 months ago, the announced daily rates were: delivery of 700 tons of "Gilsonite" ore by pipeline and processing of 275 tons of extremely low-sulfur-content electrolytic coke, quantities of fuel oil which are burned by the power plant, and 54,600 gal of high-octane gasoline.

The gasoline is reported to be excellent and the coke has been accepted by the aluminum industry. The latter is being used in some instances to make possible the use of relatively high impurity cokes by blending. In other cases, it is being used by itself.

AEC Reports on Raw Materials

The Atomic Energy Commission recently released the text of the "Raw Materials" section of the 24th Semi-Annual Report to Congress. According to the report, uranium production continued to increase during the January-June reporting period of 1958 and present and proposed domestic commitments, plus existing foreign commitments appear adequate for military and civilian requirements for the next few years.

The report stated that new proposals for additional domestic milling capacity will result in modern expansion of domestic purchases of U_3O_8 concentrate. Foreign purchase commitments have been reduced. The Commission received 5850 tons of U_3O_8 during the first six months of 1958 and predicted an annual rate of production of 15,000 tons by the end of the calendar year. Ore production rose from 2,000,000 dry tons in the last six months of 1957 to 2,500,000 dry tons during the first six months of 1958.

Bonus payments to mine operators on initial production since the inception of the program in March 1951 have totaled $12,500,000 through June 30. This bonus, in effect until March 31, 1960 provides for payments in addition to the guaranteed price, and may total as much as $35,000 for the first 10,000 lb of U_3O_8 contained in ore produced from a new property and accepted by specified mills or buying stations. The bonus program for delivery to the Commission of 20-short tons of uranimum-bearing ores or mechanical concentrates assaying 20 percent or more of U_3O_8 from any single mining location expired April 11, 1958 with Lisbon Uranium Co. of Salt Lake City, Utah, the first and only producer to make delivery and claim it. The ore was delivered on April 10, just one day to expiration of the bonus offer.

During the first half of 1958, four new uranium ore mills went into operation. They are Union Carbide Nuclear Co. at Rifle, Colo.; Homestake-New Mexico Partners at Grants, N. Mex.; Lucky Mc Uranium Corp. at Fremont Co., Wyo., and Gunnison Mining Co. at Gunnison, Colo. Mills under construction or contracted for include three at Grants, N. Mex., by Homestake Sapin Partners, Phillips Petroleum Co., and Kermac Nuclear Fuels Corp. In addition mills are under construction at Lakeview, Ore., by Lakeview Mining Co., and Fremont Minerals, Inc., at Riverton, Wyo. The Commission anticipates that it will enter into additional procurement contracts for concentrates increasing total domestic milling capacity in selected areas by a total of about 3000 tpd of dry ore and increasing annual concentrate production by about 2500 tons of U_3O_8.

The Commission estimated that reserves of uranium ores as of June 30 were approximately 78,500,000 tons at 0.28 percent U_3O_8; in addition, Government and private stockpiles totaled approximately 2,000,000 tons at the same grade. They reported there has been no significant change in these figures since December 31, 1957, development of new reserves having about kept pace with depletion by mining.

Ideal's Expansion Calls for 5½ Mile Conveyor

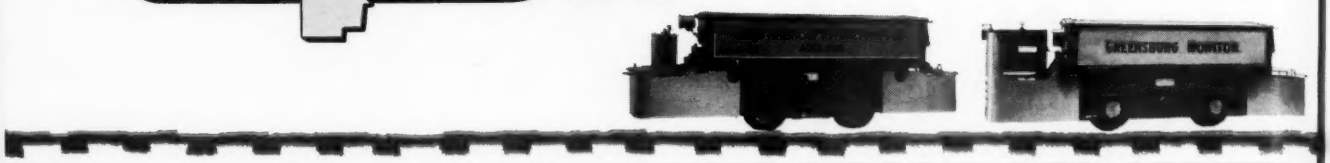
A contract for the longest permanent cross-country transport belt conveying system ever constructed, 5½ miles in length, has been awarded by Ideal Cement Co. of Denver, Colo., to Link-Belt Co. of Chicago. This unique "rubber railroad," using 36-in. wide belts, will transport 1000 tph of crushed limestone and shale from Ideal's Lawrence, Okla., quarry to its Ada, Okla., cement mill.

The entire multi-million dollar system will comprise seven conveyors. The length of the longest individual conveyor will be 11,920 ft, the longest in the world, and will require a single rubber belt more than 4½ miles long. Construction has begun and completion is scheduled for early 1959.

The belt conveyor is a part of Ideal's $22,000,000 expansion program at its Ada plant which will have a capacity of more than 3,000,000 bbl of cement annually. The Ada expansion is a part of Ideal's $170,000,000 company-wide expansion program which is designed to increase the company's productive capacity to 40,000,000 bbl annually by 1965. Ideal is one of the largest cement producers in the United States and has 15 plants in 12 States from the Gulf of Mexico to the Pacific Northwest.

National Mine Service Company

GREENSBURG MINE LOCOMOTIVES



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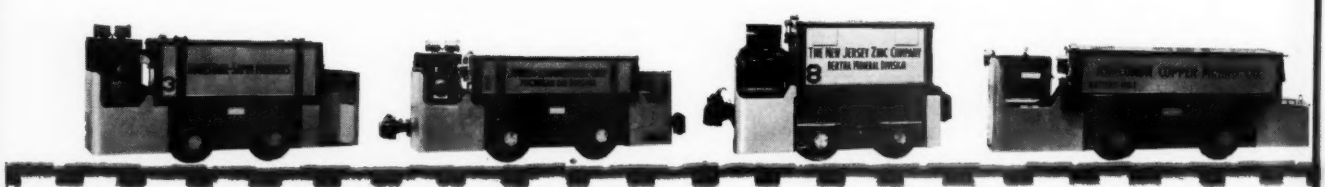

MANUFACTURING, SELLING AND SERVICING

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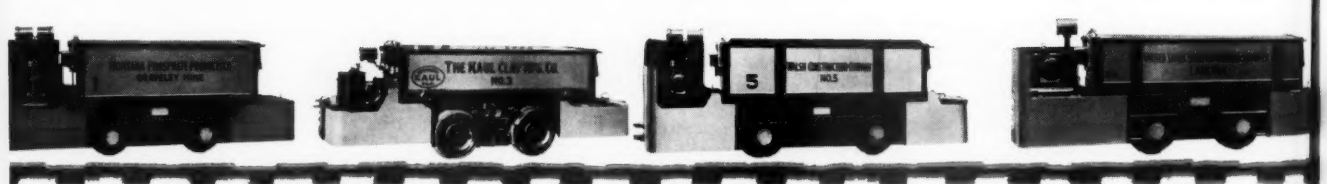
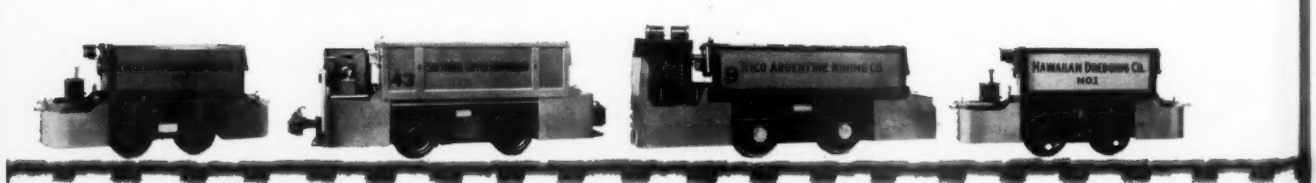


GREENSBURG MONITOR—a great name in mine locomotives—is now an integral division of NATIONAL MINE. The complete range of Greensburg Monitor Storage Battery Locomotives, from 2 to 15 tons, is backed by the service of National Mine in every major mining area. When you want *more pulling power per ton*, with longer battery life and higher efficiency for every invested dollar, check the facts with National Mine!



National Mine Service Company

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Washington Coal Fields Contain Large Reserves

Coal seams containing 70,000,000 tons of fuel have been geologically mapped in Western Washington coal fields near Centralia by the Pacific Power and Light Co. and Washington Water Power Co. Fuel tonnage blocked out since work started last September is estimated to be enough to supply a 300,000-kw steampower plant for about 50 years.

Pacific Power and WWP are conducting a joint investigation to determine the feasibility of using the area's sub-bituminous coal to augment Pacific Northwest power supplies when hydroelectric sites reach full development. Hydroelectric power development now under way in the Northwest will add 7,000,000 kw to the region's generating capacity in the next few years, but additional energy sources will be needed to meet long term needs.

Wyoming Uranium Interests To be Combined

Vitro Corporation of America, New York, and Rochester & Pittsburgh Coal Co., Indiana, Pa., joint owners of Vitro Minerals Corp., have entered into an agreement with Susquehanna Corp. of Chicago to combine their uranium interests in Wyoming. The agreement has been approved by a majority of the Susquehanna board of directors and will be submitted to Susquehanna stockholders for approval.

Susquehanna is the parent corporation of Mines Development, Inc., which operates a 400-tpd uranium mill in Edgemont, S. D., and Fremont Minerals, Inc., which is building a new mill and acid plant in Riverton, Wyo., originally designed for 550 tons capacity.

Vitro Minerals, operating in the Gas Hills area of Wyoming for four years, is one of the largest uranium miners in the State. It has uranium properties in Wyoming estimated by the AEC to contain more than 911,000 tons of ore. This estimate is based on exploration and development of approximately 22 percent of the more than 40,000 acres presently controlled by Vitro in the Gas Hills area.

Under a proposed agreement with the AEC, the new mill and acid plant at Riverton will increase its present designed capacity from 550 to more than 1000 tpd. Negotiations to this end are under way at the AEC offices in Grand Junction, Colo. It is expected that the mill will be completed in December, after which expanded mining operations will be undertaken on the present Vitro Minerals properties.

ALSO . . .

A new diatomaceous earth processing plant has been completed for The Eagle-Picher Co. near Lovelock, Nev. The new plant and equipment cost about $2,500,000, and is the latest major project in the company's diversification and expansion program. The Lovelock quarry and processing plant is the second diatomaceous earth facility operated by Eagle-Picher in Nevada. The company has been mining and processing diatomaceous earth from its deposit near Clark, 22 miles east of Reno for a number of years. Eagle-Picher is currently operating 23 plants in this country and in Mexico; and, besides the two extensive operations in Nevada, the company has important lead and zinc mining operations in Missouri, Oklahoma, Kansas, Illinois, Wisconsin and Mexico.

Four experiment stations and field establishments of the U. S. Bureau of Mines will conduct research on fluorspar and fluorine compounds during fiscal year 1959. Laboratory and pilot plant research will continue on methods for producing cryolite, aluminum fluoride and other fluorine compounds directly from low-grade siliceous or complex fluorine-bearing materials.

Pilot plant reduction of zinc oxide ores by continuous counter-current ion exchange is being planned by Techmanix Corp., a Salt Lake City research agency. Company officials stress they have no panacea and that considerable research and development lies ahead, but they assert that a zinc oxide or zinc salt product of 99.9 percent purity can be produced by their system. Such oxides need not be transformed into prime western grade zinc through retorting. A substantial market already exists for the oxides and salts of zinc. Under the Techmanix plan, the zinc oxides which heretofore were thrown aside in mining as waste—or not developed for mining in the process of recovering sulphide ores—would become an important plus factor in opening new mines or making existing properties commercial. Cost of the installation of an ion exchange circuit as an adjunct to existing lead-zinc mills is regarded as modest.

"Uranium, Thorium, Columbian and Rare Earth Deposits in the Salmon Region, Lemhi County, Idaho," published by the Idaho Bureau of Mines and Geology at Moscow, Idaho, and written by Dr. A. L. Anderson, describes the deposits that have been receiving considerable attention recently.

A private sale of uranium concentrates to Davison Chemical Co., a divison of W. R. Grace & Co., Erwin, Tenn., was recently made by Uranium Reduction Co. The sale, made with AEC permission, is the first in history between American companies involving the transfer of U_3O_8 for conversion to nuclear fuels. URC officials have also announced that the Moab, Utah, mill during the fiscal year ended June 30 treated 652,000 tons of uranim ore and produced 4,438,108 lb of yellowcake to become the nation's largest producer of uranium concentrates during that period.

Lakeview Mining Co., anticipating an early 1959 completion date of its $2,600,000 uranium mill at Lakeview, Ore., has started work on a $500,000 three-compartment shaft at its White King mine. The shaft will be sunk to 700 ft and will open one of the main ore bodies.

A $62,500 DMEA contract has been granted to Capital-Seaboard Corp. of Farmington, N. Mex., to prospect for cobalt in the Cobalt, Idaho, district. The company holds some 15 claims covering 300 acres in the area near Calera Mining Company's Blackbird Mine.

A program designed to modernize coal mining operations of Columbia-Geneva Steel Division, U. S. Steel Corp., in the Carbon County, Utah, district, was completed recently. Workmen holed through an 8962-ft tunnel 13 ft wide by nine ft high which will be used for all coal haulage from the working faces of the Columbia mine. The new tunnel eliminates a 13 percent grade, and permits access to several hundred thousand tons of quality coking coal not previously mineable. Earlier in the year Columbia-Geneva completed its multimillion-dollar coal cleaning plant near Wellington and a new general office building at Dragerton.

COG Minerals Corp., an affiliate of Colorado Oil and Gas Corp. of Denver, has acquired the assets of California Quicksilver Mines, Inc. The quicksilver concern is producing an average of 300 flasks of high purity mercury per month.

Surface coal mining was started recently 20 miles southwest of Sidney, Mont., by Knife River Coal Mining Co. of Bismarck, N. D. The mine will furnish coal for the Montana-Dakota Utilities Company's electric power plant at Sidney.

The first shaft mining operation in the Mount Spokane district of northern Washington began recently with the completion of Bear Creek Uranium Company's shaft on the Dahl lease.

A new mining company entered the nickel industry with the formation of North American Nickel Co. The company, incorporated in Delaware, combines the resources of St. Joseph Lead Co., The Bunker Hill Co., Falconbridge Nickel Mines, Ltd., and Blyth & Co. The first three companies each hold a 30 percent interest in North American, while Blyth holds the remaining 10 percent. North American's president is H. E. Lee, vice president of Bunker Hill.

It is understood that the new mining company has not as yet made any bids on properties, but that it has several sites under consideration.

One of the nation's most complete classroom and laboratory buildings went into operation on September 10 when the fall semester began at Colorado School of Mines. The $907,821 metallurgical engineering building, termed the "finest academic building for metallurgy anywhere in the country" by officials of the school, will house the entire metallurgy option taught at the mineral engineering college. Nearly 250 metallurgy students, triple the enrollment of five years ago, will call the new building their academic home. Mines offer courses in the three areas of mineral dressing, production and physical metallurgy. Currently the school is expanding its chemical metallurgy curriculum and its graduate study program.

The new facility was constructed on building mill levy funds, a source of revenue granted by the State of Colorado for construction and maintenance of academic facilities. The structure was designed to facilitate conversion of study area. The three largest laboratories may also be used as lecture classrooms and the four major classrooms can accommodate laboratory equipment.

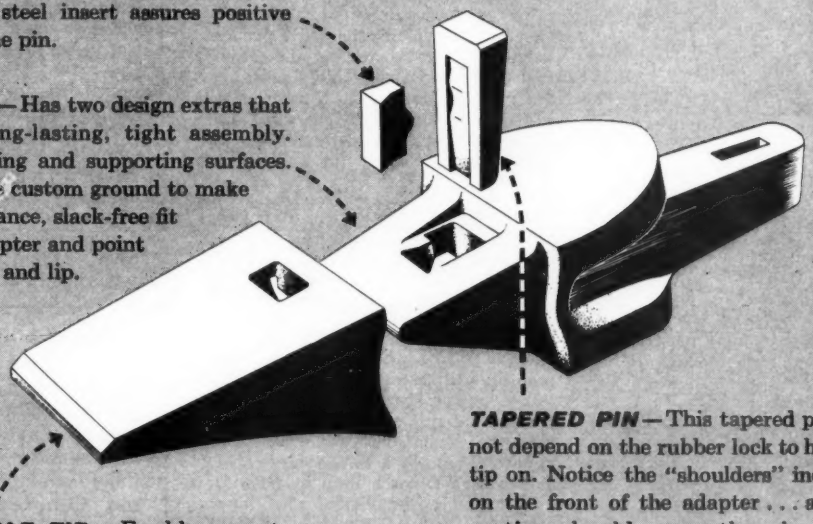
Book Review

PROGRESS IN MINERAL DRESSING. Transactions of the International Mineral Dressing Congress, Stockholm, 1957, sponsored and edited by Svenska Gruvforeningen and Jernkontoret, Almgvist & Wiksell (publishers), 26 Gamla Brogatan, Stockholm C, Sweden, Sw. Kr. 95: —(about $18.35), 754 pp.

This book is a splendid piece of work—a volume that anyone concerned with mineral dressing will want for his technical library. The book fully reproduces 34 technical papers that were given at the Mineral Dressing Congress in Stockholm in 1957. Also included are many discussions of the papers together with comments by the authors.

The entire volume is printed in English and is adequately illustrated. Topics covered include: Comminution; Classification and Gravity Separation; Magnetic Concentration, Roasting and Sintering; Flotation Theory; Flotation of Sulphide Ores; Flotation of Non-Sulphide Ores, and Mineral Processing by Chemical Methods.

NEW AMSCO® 2 PART TOOTH



PIN LOCK — Special high-strength rubber with a steel insert assures positive locking of the pin.

ADAPTER — Has two design extras that assure a long-lasting, tight assembly. Larger bearing and supporting surfaces. Adapters are custom ground to make a close-tolerance, slack-free fit between adapter and point and adapter and lip.

REVERSIBLE TIP — Enables you to get longer digging life while maintaining sharpness.

TAPERED PIN — This tapered pin does not depend on the rubber lock to hold the tip on. Notice the "shoulders" indicated on the front of the adapter . . . and the mating shoulders on the pin. These shoulders lock the tip in place with metal-to-metal contact. The rubber lock, in turn, locks the pin in place.

3 big features for fewer shovel shutdowns

1 You get up to four times extra wear over other 2-part teeth. We cast these new teeth of a tougher, new and special heat-treated alloy that slashes your replacement and maintenance costs.

2 These reversible teeth stay sharp, to penetrate cleanly and easily without straining your shovel. Reversing point is easy. This reversible feature is particularly important on corner teeth. It maintains digging efficiency throughout tooth life.

3 Positive locking device — Amsco's unique pin-locking design secures tip to adapter in tight, positive, metal-to-metal contact.

Order the Amsco 2-part Simplex from your local power shovel dealer.

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American Manganese Steel Division • Chicago Heights, Ill.

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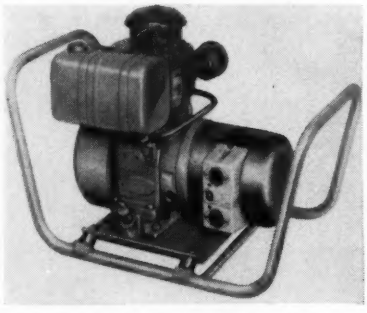
manufacturers forum

Portable Electric Generator

A DIRECT-COUPLED, beltless portable electric generator with a capacity of 2.5 kw, supplying 115 volts of direct current, has been developed by the Construction Equipment Division of Thor Power Tool Co., Prudential Plaza, Chicago, Ill. Model EG-2.5D weighs 165 lb. (dry) and is 31¼ in. long, 20 in. wide and 19½ in. high. The generator is mounted horizontally on a protective tubular frame which



also serves as a carrying handle. The aluminum control box has two 15 amp, three-prong receptacles of the straight bayonet-grounding type which also will accept two-prong plugs. The control box is available with alternate three-prong 20-amp, 125-volt grounded "twist-lok" receptacles. Model EG-2.5D's gasoline engine is four-cycle, single-cylinder, and air-cooled with an aluminum alloy pistol, stellite valves, and replaceable seats.

Gas Mask

VISUAL WARNING that a gas mask canister is no longer effective against carbon monoxide is said to be provided by a device recently adopted by the Gas Masks and Hose Masks Group of the Industrial Safety Equipment Association, Inc. The device is a window indicator which shows at a glance the condition of the canister. The left half of the window contains a dark blue indicating color, while the right half contains a light blue reference color. When the two colors match, the service life of the canister for protection against carbon monoxide is spent.

In conjunction with this adoption, Mine Safety Appliances Co. announced the All-Service Gas Mask with the Window-Cator Canister for visual indication of canister life. MSA Model S gas masks equipped with Window-Cator Canisters have U. S. Bureau of Mines approval, Schedule 14F. Accompanying the warning device is another MSA development, an external check valve which reportedly prevents exhaled air from entering the canister and provides an effective seal against entry of moisture into the top of the canister during use or storage. Conversion kits for attaching the new improvements to older type masks are available.

For further details, write to Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa., and ask for bulletin No. 0507-2.

White-Printer

DIFFERING FROM PHOTOCOPY PROCESSES, the Blu-Ray white-printer utilizes as an original anything drawn, written or typed on translucent paper to make black or blue-line copies onto sensitized diazo paper. Through a new system which drives both lower rollers by means of a belt and pulley drive, plus longer belts for reduced tension, the unit permits the processing of material of any width up to 42 in. with reportedly no tendency whatever to crease or wrinkle either the original or its copies. The machine, which requires no venting, offers the advantages of dry development by the aqua-ammonia vapor process. Escape of vapors is minimized by a transparent developer tube, that enables the operator to see when the print is ready. The white-printer is manufactured by Blu-Ray, Dept. DR, 301 Main St., Ivoryton, Conn.

Dual-Purpose Loader

AN OPERATING HEIGHT of 25¾ in. is claimed for the Model 188-D, a dual-purpose loader recently added to The Long Company's line of Pigloader loading machines. The loader has a specially-designed swing boom that is said to be advantageous in working with Piggyback bridge conveyors as well as with shuttle cars; if desired, the 188-D can be utilized with both on the same section. The loader's flat digging angle and recessed digging arms permit lifting the counter-balanced head up to 10 in. off the bottom without the strokes of the arms exceeding the over-all height of the machine. Additional details may be obtained from The Long Co., P. O. Box 331, Oak Hill, W. Va.

Mechanical Sound Detector

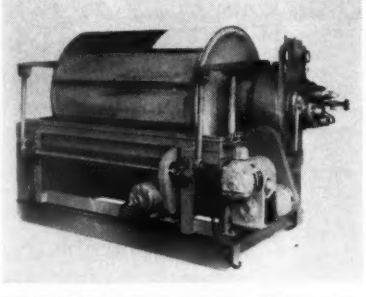
THE PORTABLE detector makes it possible to locate internal defects in moving machinery without shutting down or otherwise taking equipment out of service. According to Burke & Co., Worton, Md., the Deluxe model Binaural Engineer's Sound Detector amplifies normally inaudible defect-caused noises and helps the user to accurately locate broken, loose, worn or bent parts in engines, gear boxes, compressors, pumps and similar equipment, regardless of size. It is also said to be useful in determining the efficiency of steam traps and for locating leaks in air, gas or liquid lines.

Inquiries about new equipment appearing in Manufacturers Forum are welcomed.

For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

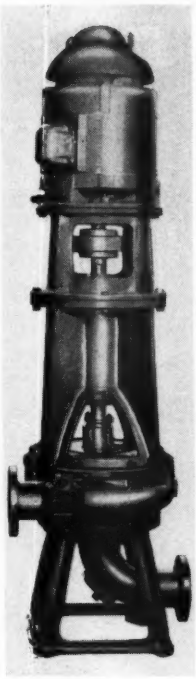
Plastic Filter

A ROTARY DRUM vacuum filter constructed of Fiberglas is available from Dorr-Oliver Incorporated, Havemeyer Lane, Stamford, Conn. This unit is said to have been developed specifically for mildly corrosive applications which normally require special



materials of construction. The manufacturer claims this plastic filter is particularly applicable to operations in which scaling is a major consideration. Components of the filter are fabricated of molded plastic with certain supporting structural members constructed of resin coated mild steel.

Pumps



AVAILABLE IN A VERTICAL as well as a horizontal model, two Wemco Torque-Flow Pumps have been announced by Wemco Torque-Flow Pump Division, Western Machinery Co., 650 Fifth St., San Francisco 7, Calif. The pumps—designated Type D and DL—are also available with a variety of drives which include belt, close coupled, pedestal mounted, and extended shaft. Type D is available in both four- and six-in. sizes reportedly suitable for general duty pumping of solids even at high heads and high capacities. Model DL is a smaller version of the same pump, available only in the four-in. size, usually used on low head applications. Both pumps have retained the design characteristics of earlier Torque-Flow Pumps. This design, featuring a recessed impeller, makes the pump non-clogging and resistant to abrasion, according to the manufacturer.

Snow Plow Wax

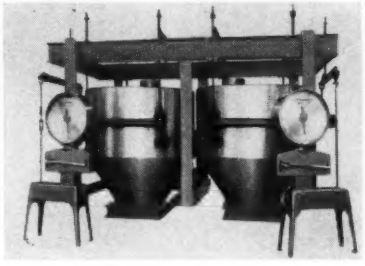
AN IMPROVED GRADE of Snow-Rem snow plow wax has been announced by Speco, Inc., 7308 Associate Ave., Cleveland 9, Ohio. Made with a high Carnauba wax and silicone content, plus non-freezing, fast-acting, quick-drying vehicles, Snow-Rem can be brushed or sprayed on outside in winter weather. By coating snow plow blades, moldboards and wings with the product, the manufacturer claims daily plowing can be greatly increased.

Crushers

TWO ROLL crushers in sizes 24 by 20 in. and 30 by 24 in. have been announced by Eagle Crusher Co., Galion, Ohio. Rolls are of manganese steel and are furnished either both smooth or both corrugated or one of each; they are turned by steel cut gears running in oil. Through tension springs one roll is fixed and the other floats, reportedly supplying ample crushing pressure yet relieving undue strain resulting from tramp iron and other foreign materials. Adjustment of the opening between the rolls (up to three in.) is accomplished by adjusting screws on either side. According to manufacturer's specifications horsepower required for the smaller unit is 75 to 125 while the larger one needs 100 to 200. Respective weights are 12,000 lb and 16,000 lb.

Ore-Weighing System

THE SYSTEM WEIGHS, RECORDS, AND PRINTS production capacities of up to 200 tph. Components



of the system are a duplex suspension hopper scale and totalizer printer. For more information, write the Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Utility Car

A THREE-WHEELED, rubber-tired vehicle, the battery operated utility car is designed for certain types of personnel transportation and light supply handling. With a capacity of 500 lb plus operator, the car reportedly has been specifically designed to include a number of features required for coal mine use. According to the manufacturer, it can be maneuvered readily in tight quarters, will operate two full shifts between battery charges, is available in either open or permissible type electrical construction, and is made in three tramming heights—24, 36 and 60 in. Named the Inspector's Friend, it is 52⅞ in. wide, 103⅛ in. long and has a speed of four mph. For additional information write The Long Company, P. O. Box 331, Oak Hill, W. Va.

Portable Rotary Air Compressor

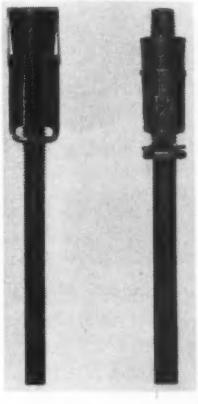
ONE OF THE WORLD'S LARGEST portable rotary air compressors, the Le Roi 1200RD2 is a twin-unit rated at 1200 cfm of free air compressed to 100 psi. The twin-unit design of two-stage, oil-cooled, sliding vane type compressors, powered by two GM 6-71 diesel engines, provides interchangeability of both engine or compressor parts for servicing. Mounted on a unit-welded steel frame and four 7.50 by 20, ten-ply tires, the 1200RD2 operates at rated output speed of 1800 rpm for the compressors and 2000 rpm for the engines. Each unit has its own independent controls and can be operated separately for 600 cfm delivery or together for 1200 cfm delivery. For more information, write the Sales Promotion Department, Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wis.

Scraper

FOR USE WITH TRACTORS OF 70 HP or more, an 11.5 cu yd scraper has been added to the LeT-WesCo line, according to LeTourneau-Westinghouse Co. of Peoria, Ill. Designed features and operational characteristics of the new DT are the same as on the other Fullpak models. It has a clean smooth bowl interior to minimize resistance in loading and unloading. The scraper's 8 ft 4 in., three section blade is said to be angled precisely with the floor of the bowl to reduce loading resistance. To provide desired "live, rolling-boiling" action in the loading process, the DT has a precisely curved deflector plate and anti-spill grid on the top of the tailgate structure. On the spread, the apron swings up to provide an opening 5 ft high. Overall length of the scraper is nearly 29 ft.

Roof Bolt Expansion Shell

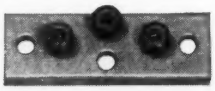
AVAILABLE IN STANDARD AND BAIL TYPES for all ⅝ and ¾-in. roof bolts, Top-Tite expansion shells have more holding power, according to the Valve Division of Thompson Products, Inc., Cleveland, Ohio. This is said to be due to two design features—fine-tooth leaves which give an even grip over their entire surface; and the largest plug possible, giving full leaf support. Other advantages claimed include no leaf breakage, no misalignment and faster tightening. One-piece leaf construction at the bottom of the shells reportedly prevents separation of plug from leaves either by fall-out or pull-out. Top-Tite shells are packaged 50 per bag in burlap bags, which are palletized for ease of bulk storage in supply areas, and are stocked and distributed by National Mine Service Co., Pittsburgh, Pa.



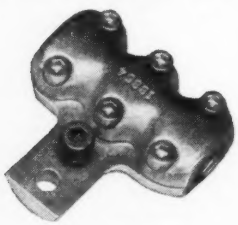
you can make over 250 different cable connections–

with O-B Cap Screw Connectors!

Straight-Thru Connector



Three-Way Connector Plate



Tee Connector

Actually, you can make a total of 259 different cable connections with the complete line of O-B "Cap Screw" Cable Connectors—and make all 259 with the same ½-inch hex wrench!

You can join copper to copper, copper to aluminum, or aluminum to aluminum cables, same size or different size, to make straight-thru, tap off, or three way connections wherever and whenever needed—faster than ever before possible!

All connections have high mechanical strength, high current-carrying capacity. All can be easily taped, dragged over rough bottom without snagging.

Ask your local O-B representative or write today for complete information on these time-, labor-, and money-saving O-B Cap Screw Connectors!

OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co., Ltd., Niagara Falls, Ont.

Ohio Brass

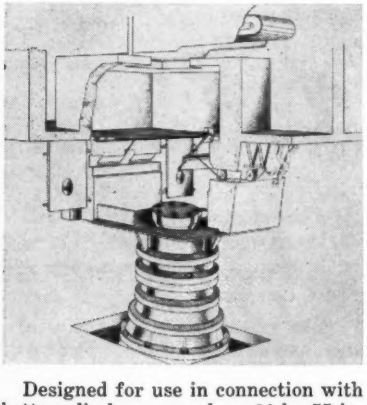
4833-M

Hose and Cable Bridge

A FLEXIBLE, INTERLOCKING hose and cable bridge has been developed for use in guarding against damage from heavy wheel traffic. Produced as a steel casting, the device weighs about 32 lb per unit. Each unit has integrally cast interlocking joints at each end to facilitate assembly of any number of units as needed without use of tools. The item, according to the manufacturer, should find use on new and in-plant construction jobs, strip mines or other areas where electric cables, water or air hoses must be traversed by trucks, cranes, or other vehicles. Further information may be obtained by contacting Calumet Steel Castings Corp., 1636 Summer Street, Hammond, Ind.

Crusher Foundation

UTILIZING A RETRACTABLE WORKING PLATFORM, an improved foundation has been developed to expedite gyratory crusher maintenance, according to Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis.



Designed for use in connection with bottom discharge crushers 30 by 55 in. or larger, the platform consists of two hinged floor sections which can be pulled up by service crane or hand operated winch to fit the inside wall of the foundation. With the platform in this position, a large open area is provided between the bottom of the crusher and the discharge conveyor for storage space.

With this new arrangement, only enough product need be withdrawn from below the crusher to lower the working platform. When the platform is lowered into position, extended car rails drop into seats provided in the foundation, and the eccentric cart can be rolled into position through the foundation's hinged, metal side doors. Then the eccentric or Hydroset mechanism of the crusher can be lowered in the conventional manner.

The new arrangement is said to provide for greater safety and speed in changing or maintaining crusher components, since it does away with the need for constructing a work floor each time.

Air-Seal Resin Process

A METHOD WHICH ALLOWS ROOF BOLTING in mines with soft and failing roofs has been announced by Pattin Manufacturing Co., Marietta, Ohio. It is also said to be valuable for use in haulageways and airways which must be kept open for many years because the method reportedly is more permanent than ordinary roof bolting.

The Air-Seal process features an air sealing plastic resin in a special container, with each container holding the amount of resin and catalyst needed for one bolt hole. The container, which is inserted into the bolt hole ahead of the expansion shell and bolt and pushed into place, is crushed between the shell and the end of the hole when the bolt is in place and tightening begins. This releases the resin flow over, around and into the shell and surrounding strata. The resin solidifies, and both shell and strata are bound together into one solid mass at the anchoring end of bolt. According to the manufacturer, the holding power of the process multiplies the holding power of a regular bolt and shell many times.

—*Announcements*—

The **Jeffrey Mfg. Co.** announces the impending retirement on December 31 of **Byron M. Bird**, manager of the company's Materials Preparation Department.

Following a ten-year association, from 1920 to 1930, with the U. S. Bureau of Mines, Bird did research on ore dressing and coal preparation at Battelle Memorial Institute from

B. M. Bird

Geo. Kepley

1930 to 1944. As a result of his work with the Bureau and Battelle he has gained a world wide reputation in the beneficiation of raw materials. He joined Jeffrey in 1944.

Replacing Bird as manager of the Materials Preparation Department will be **George Kepley.** He assumed his new responsibilities September 1.

Edwin C. Stephenson succeeds Kepley as manager of the Bluefield District Office, and **Paul Poling,** a sales engineer in the Birmingham, Ala., office replaces Stephenson in Pittsburgh.

National Mine Service Co. has established a new Canadian subsidiary, **National Mine Service (Canada) Ltd.** Initially the company will provide distribution and service of mine equipment and supplies from its office and warehouse at Elliot Lake, Ontario.

Walter E. Heinrichs, Jr., recently manager for the **Minerals Exploration Co.,** has announced the formation of **Heinrich Geoexploration Co.** With offices at West Grand Road, Tucson, Ariz., the company offers a mineral consultant and contracting service, specializing in geophysics, geochemistry, geology and economic appraisals.

Western Machinery Co. has announced the appointment of **H. K. Cogswell** as eastern regional sales manager. Headquartered in New York City, he will oversee all Western Machinery sales operations in the Eastern States.

A newly established Boston Branch Office has been announced by the Industrial Division of **Joy Manufacturing Co.** The new office is now functioning at Second Avenue, Burlington, Mass.

(Catalogs and Bulletins, next page)

CATALOGS & BULLETINS

INSULATION SYSTEM FOR MOTOR AND GENERATORS STATOR COILS. *Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.* The Silco-Flex impervious insulation system for motor and generator stator coils is described in bulletin O5B8341A. The insulating system has as its basis a semi-organic silicone elastomer characterized by extreme chemical stability and retention of original properties under adverse conditions. Important properties attributed to Silco-Flex insulation as described in the bulletin include resistance to aging, abrasion, chemicals, corona, fire, moisture, oil, solvents, fungus, carbon black, and arcing.

EARTH MOVING EQUIPMENT. *Euclid Division, General Motors Corp., Cleveland 17, Ohio.* Form 326R describes Euclid's entire line of earth moving equipment. Twenty-four different models are pictured and described in the brochure. Included are condensed specifications on nine rear dumps, three bottom dumps, three coal haulers, six scrapers, one crawler-tractor and two log haulers.

ROCK RIPPER. *Construction Equipment Division, Double J Breaker Co., Inc., Bell, Calif.* Complete specifications and application data of the rock ripper are covered. Special section explains operation of tool's breaker plate, a ripping device which works on same principle as log-splitting wedge, as it helps ripper point break up rock formations. Brochure also contains drawings and action photos of ripper working in various rock formations.

FILTER REPLACEMENT. *Advertising Division, Caterpillar Tractor Co., Peoria, Ill.* Helpful service tips on filter replacement are given in "Not An Element of Doubt," form number DE839. Filtering improvements developed by Caterpillar are explained, and cost study information coupled with recommendations for extending oil change periods are included. The importance of proper fit, temperature, stability and rate of oil flow is also discussed.

CONTROL VALVES FOR MOBILE EQUIPMENT. *E. C. Davis, Parker Hydraulics Division, Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.* Catalog 1552A10 covers Parker VDP1 hydraulic directional control valves which have nominal rating of 12 gpm. These valves are for application on earth-moving, material handling, and other mobile equipment. The catalog shows pressure drop curves and drawings for one-spool, two-spool, three-spool and four-spool models.

TRUCK FRONT END SECTIONS. *Consumer Relations Dept., International Harvester Co., 180 North Michigan Ave., Chicago, Ill.* Availablity of International truck front end sections for rebuilding or modernizing any make or model of heavy-duty truck is reported in Form CR-376-G. Kit components include cab with seats, frame, front axle, front brakes, fuel tank, clutch control, cooling system with shutters, electrical system with instruments, exhaust system, steering system and paint.

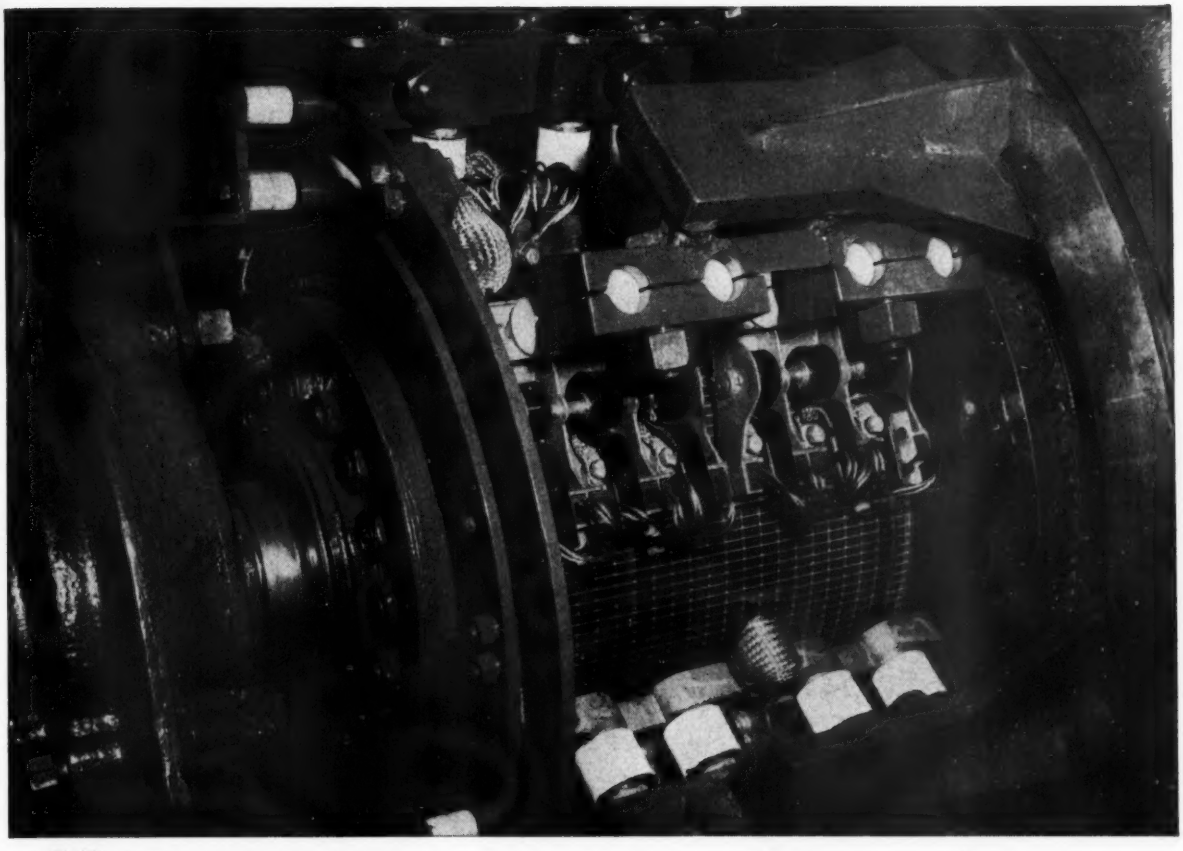
ADAPTERS FOR HOSE FITTINGS. *W. D. Wynant, Parker Fittings & Hose Division, Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.* An expanded line of adapters for reusable Hozelok fittings for industrial hose is presented in Catalog 4490. Included are various styles of connectors for male pipe threaded ends and swivel nut ends.

GEIGER TUBES. *Nucleonic Corp. of America, 196 Degraw St., Brooklyn 31, N. Y.* Bulletin N-2 describes a large range of alpha-beta-gamma end-window geiger tubes of varying window thicknesses. These include detectors with bismuth mesh cathodes that provide high sensitivity to gamma radiation.

BASIC SWITCHES. *Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill.* Catalog gives details of over 200 catalog listings of basic switches and related devices. Significant innovations in basic switches for industrial and commercial applications are included. New mounting brackets and auxiliary actuators for Micro Switch basic switches have also been added.

WIRE ROPE LUBRICANT. *Whitmore Manufacturing Co., Cleveland 4, Ohio.* Brochure describes the applications of Whitmore's wire rope lubricant. Formerly called cable composition, the product is used to minimize friction and eliminate corrosion in wire rope on many types of machinery, including draglines, steam shovels, elevators, and loading equipment.

Index to Advertisers



NATIONAL 'Improvement' Saved This Motor from the Scrap Heap

The motor shown above is one of three which powered bridge cranes on an ore unloading dock. After years of operation it was obvious that these motors had reached the point where complete rebuilding would be required to insure continued service.

The motor manufacturer considered the design obsolete and replacement parts were not available. But to replace the motors would have been extremely expensive. Not only would new motors have been required, but the existing crane structure would have had to be modified to accommodate them.

National undertook not merely to repair the motors but to redesign and modernize them. Work done included:

1. design and manufacture of new commutators
2. design and winding of new heavy duty fields
3. rewinding of the armatures
4. design and construction of more rugged brush holders and brush rigging.

As a result of National "repair and improvement", the motors were made more efficient in their performance and less costly to operate and maintain. The peak current demand of the redesigned units is on the order of 6000 amperes as compared to 8000 ampere peaks before rebuilding. And practically all of the parts now required for maintenance are standard stock items.

This case is typical of National repair service. Improvement, not merely repair, is always the objective. For details on how National redesign ingenuity can help *you* solve your tough electrical maintenance problems, just call your nearby National field engineer or drop us a line.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

MSA's continuous MinePhone research and development assures dependable underground communication in mines and areas previously thought inaccessible for this type of equipment.

Built-in → quality here

increases safety and dependability here

The motorman has clear, instant voice communication with the dispatcher or other motormen while trips are moving.

M-S-A's MinePhone helps mine operators gain and maintain fast, high-capacity haulage schedules

Briefly, here's how the M-S-A® MinePhone helps keep haulage schedules abreast of production in today's mechanized mines.

The MinePhone coordinates trip traffic for safe, fast, productive haulage control. Trip control avoids excessive power loads for economical operation. Assures better distribution of cars for peak loading efficiency.

Further, a MinePhone system reduces frequency of motormen and trip riders getting on and off trips. This saves time. Minimizes chances of injury. Reduces wear and tear on haulage equipment caused by excessive stopping and starting.

Finally, the MinePhone speeds up operations of maintenance crews. Provides an efficient, time-saving underground call system. Keeps main line haulageways free of time-consuming traffic tie-ups.

Your MSA representative would be pleased to arrange a demonstration for you. Call him in for an evaluation of your communication needs. And write us for informative literature on the MinePhone.

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pennsylvania

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
Toronto, Calgary, Edmonton, Montreal, Sydney, Vancouver, Winnipeg

MSA
SAFETY EQUIPMENT HEADQUARTERS

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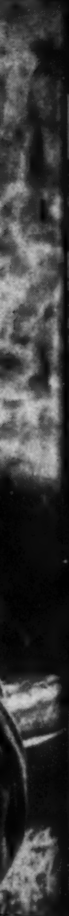

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